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AN
ESSAY
Introductory to the STUDY
OF
ELECTRICITY.

[Price Three Shillings.]

45182.

AN ESSAY ON ELECTRICITY,

CONTAINING

A Series of EXPERIMENTS

Introductory to the Study of that SCIENCE;

In which are included

Some of the lateſt DISCOVERIES;

INTENDED CHIEFLY

With a View of facilitating its APPLICATION,
and extending its UTILITY

In MEDICAL PURPOSES.

BRISTOL:
Printed for J. B. BECKET, oppoſite the Exchange, *Briſtol*; Sold
by T. BECKET, in the Strand, and G. ROBINSON, in Pater-noſter-Row,
London; D. PRINCE, at *Oxford*; W. FREDERICK,
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MDCCLXXIII.

1773

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SEVERAL Perſons in this City, who have lately furniſhed themſelves with ELECTRICAL MACHINES, *have repeatedly deſired me to give them a few plain Directions for the Uſe and Management of it—to put them in a Method of adjuſting the Apparatus for various Purpoſes, and to draw up a Series of ſuch* EXPERIMENTS *as might tend to facilitate the Study of the Science.*

I ſate down the more readily to attempt this, from obſerving that verbal Directions, and even repeating the Experiments before them, were ſeldom ſufficient either to convey a proper Idea of the Nature of Electricity, to thoſe who were Strangers to it, or to prevent their being frequently at a Loſs in ſome Part of the Operation.

I had, at firſt, no farther Intention than merely to draw up ſuch Directions and Obſervations as immediately occurred to me, for the Uſe of a few Perſons who particularly deſired them; but being at the ſame Time deſirous of promoting a farther Enquiry into the Subject, which I am perſwaded is of ſome conſiderable Importance to Mankind, I was led by this Motive to collect ſeveral of the moſt uſeful Obſervations from judicious Writers; and, by adding ſome of the lateſt Diſcoveries, to exhibit a ſhort View of the preſent State of Electricity, which I am now induced to commit to the Candour of the Public, whoſe Favours already conferred, will be ever gratefully acknowledged, by

Their devoted,

and obedient Servant,

BRISTOL,
May, 1773.

J. B. Becket.

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THE

THE PREFACE.

NOTHING, perhaps, has contributed more to the eſtabliſhment of Truth, and the advancement of genuine Science, than the tranſition from METAPHYSICAL *Reaſoning* to EXPERIMENTAL *Philoſophy*. Mere *Conjecture*, however plauſible or fondly embraced at firſt, affording at length but little ſatisfaction to the mind, we are conſtantly wiſhing for the *Evidence of Facts*; and finding but few ſpeculative Points but what are liable to be controverted, we are obliged to ſeek for demonſtrative Proof by adverting to *practical Inveſtigation.*

THIS is eminently true with reſpect to ELECTRICITY—a field of enquiry wherein *Fancy* has, indeed, ſufficiently exhibited her luxuriance. No other Science has had more admirers, nor been ſubject, in ſo ſhort a ſpace of time, to ſo great a variety of *Hypotheſes:* Theſe have been *changed*, *corrected*, and *improved*, almoſt as often as the Inſtruments and Machines which have been made uſe of upon the occaſion. Indeed, ſo little of the nature of Electricity was known before the Apparatus became conſiderably extended, that even the *exiſtence* of the Agent ſeems to have been a matter of ſpeculation; but, after the Inſtruments had demonſtrated that ſuch a Fluid actually *exiſted*, the *mode* of that exiſtence was altogether undetermined, and became a ſubject of much diſpute.

SOME have ſuppoſed the electric matter to be a kind of *unctuous Effluvia* ariſing, by means of friction, from ſubſtances termed *electrics per ſe*;— Others, the *Æther* pointed out by Sir ISAAC NEWTON, in the effects of which, a certain *ſubtile Medium* was concerned.—Some called it *Elementary Fire*, and imagined it to be a modification of the Fire they termed an *Element*; while others conceived it to be a fluid diſtinct from chymical fire, but of a nature greatly reſembling it.

AFTER two oppoſite and remarkably diſtinct Effects had been obſerved in the attractive and repulſive powers of electricity, according as they were excited in different ſubſtances, the *Theories* of electricity became more complex; and a few gentlemen, with M. DU FAYE at their head, aſſerted the exiſtence of *two diſtinct fluids*, (which they called the *vitreous* and *reſinous* electricity) in order to account for the different phænomena which they obſerved to ariſe from the excitation of ſuch ſubſtances.—To theſe hypotheſes may be added the ingenious Abbe NOLLET's fanciful doctrine of electrical *affluences* and *effluences*, which he ſo ſtrenuouſly maintained to ſo little purpoſe.

WHEN it was diſcovered that this *twofold* electricity might be procured by one and the ſame ſubſtance, and from the ſame machine, the ſubject appeared entirely in a new light, and the terms were preſently changed from *vitreous* and *reſinous* to thoſe of *poſitive* and *negative* electricity, as being much more adequate and expreſſive of the fact; and the appearances which were afterwards produced by means of this diſcovery, ſeemed ſufficient to eſtabliſh the opinion that all electrical phænomena are effected by one fluid *ſui generis*, extremely elaſtic, and attached to the particles of all other matter.

For this theory of electricity, which of all others appears to be leaſt embarraſs'd with difficulties, we are chiefly indebted to Dr. Franklin, many of whoſe *conjectures* on the ſubject (candidly offered to the world in that form) are now found to be verified and eſtabliſhed by actual experiment.

The intention of the following ſheets being chiefly to promote a more general enquiry into the nature and properties of the electric fluid, by facilitating the practical part to thoſe who have been but little converſant with the ſubject, I ſhall not attempt to illuſtrate any other *theory* than that which is now generally received, from its appearing to be the moſt rational and conſiſtent.

The late diſcoveries in electricity, which that of the *Leyden phial* has given riſe to, together with the agreeable entertainment it affords, have incited great numbers to engage in it merely for the ſake of amuſement, which, indeed, has ſometimes led to farther improvements, but it has alſo been productive of many uſeleſs and trivial experiments, ſome of which are too puerile to be worthy of much notice. It now appears, however, that electricity may be apply'd to purpoſes much more important than merely to fill up the vacancy of a leiſure hour. It ſeems to be a clew leading into many of the *labyrinths of nature*, which human induſtry has never yet been able to unfold.

FORTUNATE as the diſcovery of electricity appears to be, we have yet ſome cauſe to lament that it came too late to be inveſtigated by the penetrating genius of a NEWTON or a BOYLE—but an ELECTRICAL MACHINE in ſuch hands, would have explored greater depths than were deſtined for the diſcoveries of one æra,—theſe were, perhaps, reſerved for the preſent, or future periods of time; which, if this track of philoſophy be purſued, may be productive of the moſt propitious events.

ELECTRICITY ſeems to be a branch of ſcience in which pleaſure and utility are happily united. Were the ſubject to be attended to in no other than a *philoſophic* light, with a view of extending our knowledge of a fluid which appears to have almoſt an unlimited agency, and univerſal extent, it would be found to be an inexhauſtible ſource to the man of leiſure and ſpeculation; or, if we conſider the variety of entertaining experiments and curious phænomena that may be produced by an electrical machine, we ſhall find it to be a moſt agreeable relaxation to every mind that is capable of virtuous and rational pleaſures: But if, at the ſame time, it can be rendered ſubſervient to more material purpoſes in life, it muſt ſtrongly demand the attention of every ingenious and liberal enquirer.

Two great advantages accruing to mankind from the knowledge they have already attained of the nature of electricity, are, a method of preſerving buildings from the deſtructive effects of LIGHTNING—and, the addition of an article to the *Ma-*

teria Medica which has frequently been made uſe of with ſingular ſucceſs.

It was with a view of extending the utility of the latter, that I have in ſome of the ſubſequent pages, collected the ſentiments of different writers on the ſubject, and exhibited the particular methods which have been uſed in applying electricity for the cure of various diſorders of the human body.——To theſe I have added a collection of Cases and Cures, in order as well to point out what ſpecies of diſorders is moſt likely to be benefited by ſuch treatment, as to limit the application within proper bounds.

I have alſo ſelected ſuch Experiments as have a tendency both to facilitate the Practice, and to illuſtrate the general Theory of Electricity.

Those who are acquainted with the ſubject, will likewiſe obſerve that I have choſen the recital of evident and *known Facts*, rather than the obtruſion of any uncertain conjectures of my own—thoſe few that I have been led to advance, I deſire to ſubmit to the candid examination and correction of the unprejudiced electrician.

ERRATA.

Page 2, line 21, *for* they are *read* it is.
P. 3, l. 2 (from the bottom) *for* chair *read* chain.
P. 30, l. 20, *for* and poſitively *read* and the other end poſitively.
P. 44, l. *ult.* *for* pungeant *read* pungent.
For the late Dr. FRANKLIN (*wherever it occurs*) *read* Dr. FRANKLIN.

AN

AN ESSAY On ELECTRICITY, &c.

PART I.

Of the Nature and Properties of the Electric Fluid, *with a Series of Propoſitions, illuſtrated by eaſy Experiments; and Directions for the Uſe and Management of an* Electrical Machine.

SECT. I.

Of the Electric Fluid.

AMONG other conſtituent principles which form the material world, there has been diſcovered an amazingly ſubtile and elaſtic fluid, generally term'd *electric.* This fluid is ſuppoſed to be univerſally diffuſed in all bodies, and ſo far inherent, as to be inſeparable from them but by *force.* The earth, the air, water, and all other ſubſtances that we know of, contain a certain quantity of the electric matter, which is ſaid to be *natural* to them. As long as this natural quantity remains in any ſubſtance, its effects are inviſible, and we are totally inſenſible of its power; but, whenever the equilibrium is diſturbed, and any body is made to poſſeſs either *more* or *leſs* than is natural to it, we are immediately ſenſible of the effects, and the balance is as perceptibly deſtroyed, as when we increaſe or diminiſh the weight of either end of a ſcale-beam.

Were all bodies poſſeſſed of an equal power of retaining, and of parting with the electric fluid, we ſhould neither have the means of exciting its appearance, nor become, in any meaſure, ſenſible of its effects; but becauſe ſome ſubſtances freely admit of its paſſage through their pores, while others ſeem to be nearly impermeable to it, we may eaſily diſturb the equilibrium, by making the fluid paſs from one body to another, by means of friction; and, when it is thus accumulated or collected in any body, it may as eaſily be detained, for ſome conſiderable time, by ſupporting the electrified body on ſuch other ſubſtances, as will not admit of the fluid's paſſage.

When any body is thus ſupported by others that obſtruct the paſſage, or cut off the communication of the electric fluid with the earth, ~~they are~~ it is ſaid to be *inſulated.*

All ſubſtances that freely permit the fluid to paſs through them, are called *non-electrics*, or *conductors*; and thoſe which are found not to admit of ſuch free paſſage, are termed *electrics*, or *non-conductors*.

Metals of every kind, are the moſt perfect conductors; next to theſe are *charcoal*, and the *fluids* of the *animal body*; *water* is alſo found to be a good conductor; *green vegetables*, *moiſt wood*, *flax*, &c. conduct in a leſs perfect degree.

The beſt electrics, or non-conductors, are *glaſs*, *ſealing-wax*, *ſulphur*, *roſin*, *bees-wax*, and *baked wood*; the *air*, when free from moiſture, is alſo a very perfect electric; and moſt kinds of *oil*, *ſilk*, and *hair*.

When any perfect electric is rubbed with one that is leſs perfect, the electrical fluid will leave the latter, and be accumulated upon the former; Thus, in working a common electrical machine, the glaſs globe, or cylinder, having a light preſſure, and friction againſt the leather cuſhion, or rubber, the fluid is collected from the rubber, from the perſon who turns the machine, from the table, &c. or rather, *through* all theſe, from the earth. It is accumulated on the ſurface of the glaſs, from which it is immediately received by the ſharp-pointed wires, called the *collectors*, and, through them, conveyed to the *prime conductor*; this being ſupported either by glaſs, ſilk, or ſome other electric, the fluid will be detained on it till it is imbibed by the humidity of the air, or taken off by the approach of ſome conducting ſubſtance. If a perſon preſents a piece of metal, or the knuckle of his hand, to the conductor, the electric matter will fly off in a ſtrong ſpark, and be re-conducted to the earth through his body.

That the electric fluid is collected chiefly from the earth, may be rendered very evident, by inſulating, or cutting off the communication of the rubber, by means of glaſs, or a piece of baked wood;[a] though the machine acts now, with the ſame vigor it did before, yet, after one or two ſmall ſparks be drawn, no more of the electric fire will iſſue from the conductor, except the very ſmall quantity collected from the air. But, in ſuch circumſtances, if a chain be hung from the rubber, ſo that one end of it may touch the table, the fire will be produced as before, and, in a dark room, there will be an appearance of ſeveral bright ſparks on the chain If a perſon points his finger to the rubber (the chain being taken away) the fire will be

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[a] Every machine, intended for experiments, ſhould be furniſhed with this convenience, for occaſionally inſulating the rubber; as, without ſome ſuch method, a perſon will be apt to conceive but a very imperfect idea of the nature of the electric fluid.

be ſeen to iſſue from it, to the rubber, in a beautiful pencil of rays.

If the machine be not furniſhed with an inſulated rubber, we may take another method to prove that the electric matter proceeds from the earth. Let a perſon take an electrical glaſs tube, and, by drawing his hand, with a piece of flannel in it, over the ſurface, he will preſently find the tube become electrified. The matter, leaving his hand, paſſes to the glaſs, where it remains, as an addition to its natural quantity; for, as neither the glaſs nor the air are conductors, the redundancy of the electric fluid cannot eſcape, till ſome non-electric body approaches it. If a piece of metal, or the hand, be preſented to any part of the tube, the fluid will paſs from it to the metal, with a crackling noiſe, and, in the dark, long flaſhes of fire may be ſeen. But, if the perſon that rubs the tube ſtands upon a ſtool, or board, ſupported by glaſs legs, he will be circumſtanced like the inſulated rubber. Another perſon, on the floor, applying his knuckle from one end to the other of the excited tube, will, after the firſt or ſecond time, be able to get no more fire from it, as none can go to it from the earth. The perſon ſtanding on the ſtool will then have a *deficiency* of his natural quantity of the fluid, or become electrified *negatively*, (which term will be farther explained hereafter) and, if he touches any other perſon, will receive a ſpark, which again reſtores the balance.

That the electric fluid is of a nature highly elaſtic, and its particles ſtrongly repulſive of each other, appears evident from the amazing ſpring and velocity which it acquires, when condenſed; and we find its ſubtilty, and rapidity of action to be ſuch, as inſtantly to pervade the pores of the moſt denſe and ſolid metals, the moment it is releaſed from a ſtate of compreſſion; and this may be effected through a circuit ſeveral miles in length.

THE ſimilarity of the appearance and effects of the electrical fire, to thoſe of *lightning*, has been remarked, by writers on the ſubject, ſome years ſince. [redacted] Dr. FRANKLIN, of *Philadelphia*, and ſome other ingenious gentlemen, have, by ſeveral concluſive experiments, proved the *cauſe* and *effects* of both to be not only ſimilar, but have alſo demonſtrated their identity: So that the *exploſions* which are produced by means of an electrical machine, are no other than *thunder and lightning*, in miniature, diveſted of their tremendous effects. The appearance and effects of lightning, may be exactly imitated by electricity; and moſt electrical experiments may be performed by the electric matter drawn from the clouds, by means of ſilk kites, raiſed during a thunder-ſtorm, or by pointed iron rods, erected on the top of a building.

MANY other phœnomena, and appearances of nature, may be agreeably imitated and explained by electricity; viz. the *aurora borealis*,—a *tornado*, or water-ſpout from the Sea—a *whirlwind* on the land, &c.—but of theſe hereafter.

PHILOSOPHERS are not yet entirely agreed in opinion whether the electric fluid be of the ſame nature, and a modification of *fire*, or whether it be a fluid *ſui generis*. There are, at leaſt, ſome few gentlemen who, in order to ſtrengthen a favourite hypotheſis, have taken great pains in attempting to prove the identity of common, or, as it is generally termed, *culinary fire*, and *electricity*; but it muſt be confeſſed that neither their arguments nor experiments appear, by any means, ſufficiently concluſive. The luminous appearance of the electric fluid, and more eſpecially, its being capable of kindling inflammable ſubſtances, have been common and plauſible arguments in ſupport of this opinion; but theſe are far from being ſatisfactory to the unprejudiced mind.

WE know there are many ſubſtances in nature which, in the dark, aſſume a lucid appearance, but in which, one of the moſt eſſential properties of *fire* is wanting. As all kinds of *friction* and *colliſion* are, more or leſs, productive of *heat*, it ſeems to be with great propriety that we always annex an idea of *heat* with *fire*; the former muſt be a neceſſary conſequence of the latter, which is ſuppoſed to be a *peculiarly violent agitation*, into which the inflammable parts of bodies are thrown, by a certain degree of friction, which is neceſſary to *generate* or *produce* it.

IF the above definition of fire be admitted, (and I think we have the authorities of a BACON, a BOYLE, and a NEWTON to ſupport it) it ſeems not much to be wondered at, that the parts of ſubſtances which are eaſily inflammable, ſhould be kindled into fire by the rapid tranſition of the electric fluid through them.[b] Nor is the conſequence of ſo ſudden and violent a friction more than what might be expected, when we find that wires, of ſome conſiderable thickneſs, may not only be made red hot, but may alſo be put into a fuſion, and even be vitrified, and entirely diſperſed, by a ſtrong electric *exploſion*, and this in an inſtant of time; which is not to be effected by the moſt ardent culinary fire that we are able to procure.

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[b] In a Tract written by Dr. HOADLY and Mr. WILSON, intitled "*Obſervations on a Series of Electrical Experiments,*" is the following obſervation,—"It is improper to call the *Electric Fluid* "FIRE; Air may juſt as properly be called Sound, as this fluid "may be called Fire. When ſound is produced, the particles "of air are put into ſo regular a motion, as to convey ſuch ſen- "ſations, by means of the ear, as raiſe the idea of ſound. But "air is not therefore ſound. In the ſame manner, when a bo- "dy has all its component particles thrown into ſuch agitations "in the air, by the force and action of this fluid within it and "without it, that it grows hot and ſhines, and glows and con- "ſumes away in ſmoke and flame, we ſay the body is on fire, "or burns: But this fluid is not therefore *fire*; nor can it, "without confounding our ideas, have that name given to it: "Nor indeed can *fire* be called a principle or element, in the "chymiſt's ſenſe of the word, any more than ſound can.

But, if we ſuppoſe the electric matter, and fire, to be the ſame, there ſeems to be a difficulty in accounting for the remarkable difference which appears in the modification and effects of the electric ſpark, and that which is produced by the colliſion of flint and ſteel. When the electric fluid is accumulated on the prime conductor of a machine, the ſpark may be drawn from it at the diſtance of ſeveral inches, and it flies off with ſo great a rapidity, that we are not able to diſtinguiſh its direction, whether it proceeds *to* or *from* the conductor; and in the inſtant that the ſpark is drawn, it intirely diſappears, and ſeems to be totally enveloped in the common maſs of matter: on the contrary, the ſpark from the ſteel has a comparatively ſlow progreſſive motion, and, when received upon the ſurface of any body, it will ſometimes remain a conſiderable time, before it becomes extinct; nor has it any appearance of the power of attraction, or repulſion.

In the ſmalleſt ſpark of *fire*, there is a ſenſation, or quality, of *burning*, and *heat*; but in one, much more lucid and intenſe, taken by the knuckle from the electrified conductor, no degree of heat is perceptible.

A very conſiderable quantity of the electric fluid may be condenſed in a coated glaſs receiver, without being rendered viſible; but the imagination muſt be ſomewhat ſtrained, in the conception of ſuch a quantity of *compreſs'd fire*, intenſe and, at the ſame time, *inviſible*.

A dense *air* is found to be neceſſary to the exiſtence of culinary fire, but the electric fluid evidently ſubſiſts *in vacuo*, at leaſt, in the moſt perfect vacuum that we are able to procure. Many other reaſons, and experiments, might be advanced, to ſhew that our ideas of *electricity*, and of *fire*, ought not to be confounded, though the former may produce the latter in abundance of inſtances;—but as my deſign here, is by no means to controvert the opinions of others, I have mentioned the preceding obſervations with no other intent than to guard againſt the admittance of any haſty and immature concluſions. Indeed we know ſo little of the origin and extent of *fire*, that it cannot appear ſtrange, if men of the greateſt penetration have been divided in their opinion of it; and, after it has been ſubject to the inveſtigation of the illuſtrious perſons before named, the deciſions of future enquirers ſhould be pronounced with a becoming diffidence.

WITH reſpect to the *electric fluid*, we are able, by the help of the machine, and its appendages, to inveſtigate ſeveral of its properties with ſome degree of preciſion; though concerning others, it muſt be confeſs'd that we can yet do little more than conjecture: The moſt probable opinion, however, ſeems to be that of Dr. FRANKLIN, who ſuppoſes it to be fluid *ſui generis*, univerſally diſperſed through the pores of all bodies.[c] This gentleman, as before obſerved, has ſatisfactorily proved that it is of the ſame nature as *lightning*, extremely ſubtile and elaſtic, its particles ſtrongly repulſive of each other, and attractive of the particles of matter; moſt of theſe Properties may be clearly demonſtrated by experiments, for which purpoſe ſeveral of the following are deſigned.

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[c] Whoever are deſirous of ſeeing this ſubject properly handled, I would refer them to the peruſal of Dr. FRANKLIN's Letters, moſt of which have been publiſhed in the Philoſophical Tranſactions, but are now collected into one volume;—and to the Hiſtory and Preſent State of Electricity, written by the ingenious Dr. PRIESTLEY, a work I ſhall venture to recommend to the peruſal of every perſon who has an inclination of making himſelf acquainted with the ſubject, as far as it is hitherto known.

SECT. II.

Of the Electrical Machine, *with Directions for the Uſe of it.*

THESE Machines, ſince Electricity has become a common ſubject of enquiry, have been made in a great variety of forms, and on different conſtructions. Few of them are very complicated; but the machine which, on ſome accounts, I would prefer to any other, and which anſwers every neceſſary purpoſe, is the moſt ſimple that can well be conceived. It conſiſts of a glaſs cylinder, 12 or 14 inches in length, by 9 or 10 in diameter; ſmaller than this will not ſo well anſwer the purpoſe. It is turned, in a vertical direction, by a ſingle wince, without any accelerated motion from wheels, and without any axis, or ſpindle thro' it. The rubber, or cuſhion underneath, is ſupported on a braſs ſpring, and may be *inſulated* or otherwiſe, at pleaſure, by means of a plate of glaſs, adjuſted to a ſocket. The *prime conductor* may be placed either on the right hand, or left, as is moſt convenient. There is alſo a *negative conductor*, of the ſame form and ſize as the *poſitive*, or prime conductor: They may be ſupported either on glaſs ſtands, or phials, and placed in any required direction, or diſtance from each other, by which means both the *poſitive* and *negative* electricity, may be obtained without the leaſt trouble.

The moſt material thing in a machine is a good cylinder, (which, for many reaſons, is preferable to a globe) made of a proper glaſs, form, and ſubſtance; that will be excited with a gentle and eaſy friction. I have always found thoſe cylinders to act the beſt that are lined on the inſide with a thin lining of electric ſubſtances. The following compoſition is a very good one for the purpoſe; Half a pound of roſin, half a pound of bees-wax, with two pounds of venice turpentine, boiled for two hours over a gentle fire, keeping them ſtirred; a ſmall quantity of vermilion may then be ſtirred in with it, and afterwards left to cool. A ſufficient quantity of this mixture is then to be put into the cylinder, which muſt be turn'd round, over a clear fire, till it is evenly ſpread over all the inſide, and then left gradually to cool.

There is frequently a very material difference in the nature of the glaſs with which the cylinders are made. I have tried ſeveral ſorts both of green and white flint, but with ſo various ſucceſs, that I cannot pretend to determine which is to be preferred. I have had many cylinders, to all appearance, very well made, but which could by no means be excited; till after having the above lining, they have proved extreamly good: Indeed I never yet met with a lined cylinder but what acted tolerably well; and I have generally found that the longer they have been made, and the more frequently they are uſed and rubbed, the more powerfully they may be excited.

When the cylinder is in good order, and acts vigorouſly, on preſenting the knuckle near it, there will not only be a ſenſible wind, a hiſſing noiſe, and ſtream of light from it, but very bright ſparks, and circles of fire will be ſeen to dart from the knuckle, over the ſurface of the cylinder, to the rubber, the contrary way to which the cylinder is turned, attended with a ſnapping noiſe, and tingling ſenſation in the part from whence it ſeems to iſſue: But this will not always be the caſe, nor is it requiſite,—if an air be found to come from the cylinder, attended with a crackling noiſe againſt the knuckles, the machine will act ſtrong enough for almoſt any experiment. If nothing of this be perceived, the cylinder muſt be gently rubbed with a piece of flannel, or a ſoft, dry handkerchief; ſometimes, particularly in damp weather, and when the machine has not been uſed for ſome time, it will be neceſſary to bring it for a few minutes before a fire, and to make the cylinder a little warm. If this does not do, take off the rubber, and lightly ſtroke the ſurface of it with the end of a tallow-candle, and afterwards rub over it a ſmall quantity of what is called *Amalgam*;[d] this ſeldom fails to make the cylinder act with much greater ſtrength. Sometimes merely rubbing the ſurface of the rubber with the end of the finger, in order to take off a kind of poliſh, which in time it acquires, will be ſufficient to give the machine freſh vigor. If the amalgam be uſed, the cylinder requires to be wiped occaſionally, to get off the black rough matter, that will ſometimes be found ſticking to it.

Those cylinders that will act with a light preſſure againſt the rubber, and a motion moderately ſwift, are always the beſt, as they ſave much labour in working the machine; and it will generally be neceſſary to adjuſt the rubber, and put the cylinder in proper order, before any experiments are entered upon; and afterwards, occaſionally to tighten or ſlacken the adjuſting ſcrew. After the cylinder has been work'd for ſome time, it will be found to turn leſs eaſy than it did at firſt, as though it preſſed too hard againſt the rubber, and leſs fire will generally be produced; in this caſe, a coarſe linen cloth, on which has been rubbed a ſmall quantity of candle-tallow, may be held againſt the cylinder as it turns, and it will immediately turn eaſier, and act as vigorous as before.

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[d] This is a compoſition which no perſon that has a machine, ſhould be without, as it never fails to increaſe the power of it. The Amalgam is uſually made of *quickſilver*, and the ſcrapings of *pewter*, *lead*, or pieces of *tinfoil*, mix'd together, in a hot marble or glaſs mortar; if a ſmall quantity of *vermilion* and *biſmuth* be added, this mixture will be found very ſerviceable.

BUT however well the cylinder may act, it will be in vain to expect any experiments will ſucceed properly, unleſs the prime conductor be *perfectly inſulated.* It may eaſily be known if it be not ſo, by taking a ſpark from it, which will never be ſtrong, nor drawn but at a ſmall diſtance. If the conductor be ſupported on glaſs, this muſt be rubbed perfectly dry, or held to the fire, till it be ſomewhat warm; or if ſilk lines be uſed, the ſame drying will be neceſſary. All roughneſſes, edges, and points on the conductor, or its ſupporters, that may throw off the fluid into the air, ſhould be properly ſecured, and rounded off.

THE pointed wires, or collectors of the fire, ſhould be placed within half an inch of the cylinder, directly facing, or parallel with the rubber, ſo that all of them may be within the central force, and greateſt influence of the glaſs; for if any of the wires extend too far toward either end of the cylinder, inſtead of collecting, they will throw off the fluid, which, in the dark, may be ſeen in the appearance of a ſmall ſtream of blue fire, extending itſelf toward the end of the glaſs; the collector ſhould then be moved, either one way or the other, till the points of all the wires are illuminated with a ſtar, or ſpeck of light, without a ſtream from any of them. For this reaſon, the rubber ought generally to be about two inches ſhorter than the cylinder, and the extent of the wires leſs than the length of the rubber, by at leaſt one inch.

I HAVE been the more explicit and particular in theſe directions, becauſe I am ſenſible that the young Electrician frequently undergoes no ſmall degree of vexation, when he is not able to collect a ſufficiency of fire for his experiment, and is at a loſs to know the reaſon: Though he may be poſſeſſed of a good machine, he may not be able to uſe it to the beſt advantage; and if he cannot put it in proper order, he will be obliged

bliged to beſtow much unneceſſary labour and time in charging his phials, &c.—but a little practice and attention will ſoon enable him to overcome every difficulty of this kind.

But he is not to expect that his machine will act equally well at all times. The *weather* has generally great influence on electrical experiments: When it is dry and clear, and particularly in froſty weather, they always ſucceed beſt; if it be rainy or damp, the electric matter will be attracted by the humidity of the air, and very little can be procured from the conductor. In this caſe, there ſhould be a good fire in the room, to dry and warm all the glaſs materials,—we may then proceed without much interruption. But, on the other hand, if the weather be very dry and warm, the floor of the room and furniture, being without a proper degree of moiſture, become very bad conductors, and little of the electric matter can be brought through them from the earth. Some kind of metallic conductor ſhould now be fixed, ſo as to connect the rubber of the machine with the ground, or walls of the houſe. I generally make uſe of a braſs chain, one end of which is faſtened to the rubber, and the other end put through a ſmall hole in the carpet on the floor, under which is ſheet lead; by this means I generally collect as much of the electric fluid as I deſire. But in very hot weather few experiments can be made to ſucceed properly, for though the glaſs may act tolerably well, no other than a ſmall hiſſing ſpark can be taken from the conductor, and at a ſmall diſtance;—in theſe circumſtances, I own I know of no other remedy than *patience*, and if this be not at hand, I think the beſt way, for the preſent, will be to lay the machine, &c. wholly aſide.

I must yet add another caution or two, which, though they may appear trivial, may not be altogether un-

unneceſſary to thoſe who are entering upon electricity. After the machine and apparatus have been uſed, they are not to be careleſsly laid aſide in any place, nor left expoſed to the air; but ſhould either be put up in a box, or covered over with a cloth, to preſerve them from the moiſt air, and duſt. The axes of the cylinder, &c. ſhould be now and then freſh oiled:—All the *glaſs* materials, particularly, kept perfectly clean and dry, and theſe *handled* as little as poſſible.—If any conducting ſubſtance be near the machine, when working, it generally receives a part of the electric matter, and carries it off; it is therefore proper to remove every thing, that is not immediately wanted, to a diſtance. The flame of a candle, near the cylinder, or any part of the conductor, effectually takes off the electricity, and ſpoils the operation.

SECT. III.

Remarks, and general AXIOMS *in* ELECTRICITY.

AN ELECTRICIAN ſhould diveſt himſelf of *fear*, though not of *caution.* There is no poſſible danger in any electrical experiments, except in the charging of large jars and *batteries*; nor need he be under any apprehenſion from theſe, while he is careful not to touch any part of the conductor, or the wires leading to the inſide of the jars. But I know it to be not unuſual for perſons, who are but little acquainted with the nature of electricity, to teſtify evident marks of fear, upon their approaching an electrical machine. Some can ſcarcely be prevailed on to receive the ſlighteſt diſcharge from the phial, or even to take a ſpark from the conductor, though they ſee others before them experience both, without the leaſt inconvenience.

This want of reſolution might be excuſable in women and children, but I own I cannot help ſmiling at the timidity of a man who can expreſs any apprehenſions of a momentary ſmart,—of a pain which is rather imaginary than real, as it can ſeldom be of half a ſecond's duration; and I never knew it to be attended with the leaſt diſagreeable conſequence.

THE mind is, perhaps, as readily ſuſceptible of the *fear* of pain, as the body is of pain itſelf; hence our ideas of that which we have heard from the report of others, to be in any degree painful, ſeem to be magnified far beyond reality. When the force of condenſed electricity was firſt accidentally experienced by Mr. CUNEUS, and afterwards by Profeſſor MUSHENBROECK, Mr. ALAMAND, and ſome others, at *Leyden*, about the year 1726, the very exaggerated accounts thoſe gentlemen gave of it, could proceed only from the ſurpriſe and terror they were thrown into by ſo extraordinary an event; for the experiment, it ſeems, was made with only a common phial, with water in it. Were not we able to repeat the ſame experiment, and in a manner much more forcible than they could perform it, we ſhould undoubtedly, entertain far more tremendous ideas of it than what it really is. Though the Profeſſor was ſtruck with ſo terrible a panic that he declared, "he would not take a ſecond ſhock for the kingdom of France," yet we find that a ſhock ten times as great, may be received without injury.[c] There being generally in the human frame, ſo little reſiſtance to a free paſſage of this ſubtile fluid, that the quantity compreſſed in a common phial (uſually leſs than a ſquare foot of coated glaſs) can be attended with no other inconvenience than giving the inadvertent operator a tranſient diſagreeable ſenſation.

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[c] Dr. PRIESTLEY, in his Hiſtory of Electricity, ſays, "I once "inadvertently received the full charge of two jars, each con-"taining three ſquare feet of coated glaſs. The ſtroke could "not be called painful; but, though it paſſed through my arms "and breaſt only, it ſeemed to affect every part of my body a-"like. The only inconvenience I felt from it, was a laſſitude, "which went off in about two hours.

A diligent attention, however, is required, when he has occaſion to uſe a conſiderable force. He ſhould be pretty well acquainted, not only with the courſe which the fluid will take, in different diſpoſitions of the apparatus, but alſo with the qualities of different conducting or non-conducting ſubſtances, which he may have occaſion to uſe in diverſifying his experiments. He would alſo do well in providing himſelf with an *Electrometer*, for determining the power and quantity of the charge, before the exploſion is made.[f] The force contained in a great number of coated phials (uſually called an *Electrical Battery*) is very conſiderable; perhaps the matter condenſed on a hundred ſquare feet of coated glaſs, would acquire a degree of force ſufficient to ſtrike a man inſtantly dead: But they are ſeldom made, or required to be ſo large as this.

I am ſenſible that to the *Electrician*, the preceding obſervations, and indeed moſt of the ſubſequent, will be unneceſſary; but, perhaps, he may recollect the time when he would have been glad of them,—when the knowledge of a few plain rules and maxims would have ſaved him much labour and expence; but, (to uſe the words of Dr. Priestley) "it is hoped he will "not envy others acquiring knowledge cheaper than "he did himſelf. It is for the intereſt of the ſcience "in general, that every thing be made as eaſy and "inviting as poſſible to beginners. It is this circum"ſtance only that can increaſe the number of electri

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[f] The beſt kind of Electrometers for this purpoſe, that I have ſeen, is that invented by Mr. Henley, of *London*; and ſold by Mr. Nairne, in *Cornhill*.

"cians, and it is from the increaſe of this number,
"that we may moſt reaſonably expect improvements
"in the ſcience."

It was chiefly with a motive of inviting others into this ample field of enquiry, in which I own I have frequently taken moſt agreeable excurſions, that I have attempted to open a view of ſome of the moſt ſtriking appearances which ſeem to be worthy of the enquirer's attention; in the purſuit of which, he may avoid others that have been found to be illuſive; and, by ſtriking a little out of the uſual track, I have endeavoured to vary the common experiments, uſually exhibited merely for amuſement, ſo as to render them, at the ſame time, collateral proofs of ſuch propoſitions as are neceſſary to be kept in view:—The moſt material are the following; which, as they are leading principles that are eaſily demonſtrable, may be called

AXIOMS in ELECTRICITY.

1. We ſay a body is electrified *poſitively*, or *plus*, when it has received *more* than its natural quantity of the electric matter: And

2. When the natural quantity is *leſs*, or diminiſhed, in a body, it is ſaid to be electrified *negatively*, or *minus*.

3. All bodies in contact with the prime conductor of a machine, will be electrified *poſitively*, or contain a redundancy of the electric matter.

4. If the rubber of the machine be *inſulated*, and, at the ſame time, a chain, or other non electric, be hung to the prime conductor, ſo as to convey the matter to the ground, the rubber, and all bodies connected with it, will become electrified *negatively*.

5. WHEN two, or more, bodies are electrified *poſitively*, they *repel* or avoid each other.

6. WHEN two, or more, bodies are electrified *negatively*, they likewiſe *repel*; but

7. WHEN one body is electrified poſitively, and another negatively, they ſtrongly *attract*:—And

8. ANY body electrified either negatively or poſitively, will attract another body that is ſuppoſed to remain in its *natural ſtate*, or unelectrified;—there appears, indeed, to be a mutual attraction between both:—But, ſtrictly ſpeaking, no body that approaches another which is electrified, remains abſolutely in its natural ſtate, or unelectrified, becauſe

9. "ALL bodies that are brought within the in-
" fluence of electrified bodies, (whether they are ſo
" by having *more* or *leſs* than their natural ſhare of the
" electric fluid) become poſſeſſed of a contrary elec-
" tricity."

10. ON preſenting the wire, which communicates with the inſide of a coated phial, to the prime conductor, the inſide of that phial will be electrified *poſitively*, and the matter become condenſed on the *inſide* coating to a great degree,—at the ſame time that the *outſide* coating will become, in the ſame degree, *negatively* electrified.———On the contrary, if the phial be held in the hand by the wire, and the external coating be preſented to the prime conductor, the inſide of that phial will become electrified *negatively*, and the outſide *poſitively*.

11. THINGS being in the ſituation as mentioned in Ax. 4. on preſenting the phial to the rubber (or to a conductor in contact with it) its electricity will be directly reverſed—If the *wire* be held to the rubber, the inſide of the phial will be electrified *negatively*, and the

outſide *poſitively*;—If the *outward coating* be preſented, the inſide will be *poſitive*, and the outſide *negative*.

12. POINTS, or pointed bodies, (as the ſharp end of a wire, needle, &c.) have a peculiarly powerful effect, both in *receiving* and *throwing off* the electric matter from any body electrified.

13. A globe, cylinder, or tube of glaſs made *rough* on the ſurface, will produce a *negative* electricity, if the friction be made with a *ſmooth* rubber; as will likewiſe a cylinder of *ſealing-wax*, or of *ſulphur*,—contrary to that of ſmooth glaſs, which always throws out a *poſitive* or *plus* electricity.

SECT. IV.

A Series of introductory EXPERIMENTS.

ELECTRICITY ſeems to demand a more *practical attention*, in order to inveſtigate its properties with ſatisfaction, than perhaps any other ſcience: Nor is it eaſy to convey an adequate idea of its ſurpriſing effects, without the help of *experiments*. If a perſon has once or twice ſeen a few of theſe, and attentively obſerved the mode and reſult of each operation, he will have a much clearer conception of electricity in general, and the uſe of the various apparatus, than any verbal directions can convey; but ſuch directions, when the machine is at hand, have a tendency to facilitate the practice, and may poſſibly bring to the recollection, ſome appearances which might have been but ſlightly noticed, though neceſſary to be well underſtood, in order to purſue the ſcience with ſucceſs.

FOR this purpoſe I have endeavoured to ſelect ſuch experiments as are not only entertaining, but illuſtrative

tive of the preceding propoſitions.—The firſt that naturally preſents itſelf is

Drawing the Electric Spark.

Exp. 1. This is performed merely by preſenting a knuckle of the hand, the knob of a diſcharging rod, or any other non-electric, within about an inch of the prime conductor, from which electric ſparks, in the appearance of fire, will be ſeen to dart, attended with ſmall exploſions, and will be felt by the hand like a ſtroke given with the end of a ſmall wire.

Exp. 2. If the knob of the diſcharging rod be applied near the end of the conductor, or near to the glaſs ſtand that ſupports it, a much longer ſpark may be drawn, than from the middle; and it will be ſeen to form ſeveral curves in its paſſage, having the exact appearance of a flaſh of lightning.

When any body, in its natural ſtate approaches another that is electrified, (as in the above experiments) the condenſed matter in the electrified body repels the natural quantity from the body unelectrified,[g]—from the ſurface neareſt in contact, to its remoter parts, by which means that ſurface becomes electrified *negatively*, or in a ſtate proper to receive a ſpark from the body which is over-charged with the matter, till, upon a nearer approach, it receives from the other all the compreſs'd fluid, in one exploſion, which is inſtantly conveyed to the earth through the perſon who drew the ſpark.

I apprehend the violence of this attraction to proceed from two cauſes,—the repulſion of the electric particles to each other, and their attraction to the particles of matter. The denſe fluid, in a body ſtrongly electrified, muſt neceſſarily repel that which is more rare, in the body unelectrified, and remove it to a diſtance adequate to the elaſtic force acquired by the former; by which means, that part of the unelectrified body which is neareſt to the other, becomes a kind of *vacuum*, as attractive of the particles condenſed on the electrified body, as they are repulſive of themſelves.

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[g] See Ax. 9. This will be proved in a ſubſequent experiment.

On the approach of a body in its natural ſtate to one that is electrified *negatively*, the ſame effects enſue as in the former caſe, but from a cauſe juſt the reverſe: The ſurface of the approaching body now becomes electrified poſitively, the fluid being drawn from its remoter parts, towards the body negatively electrified; hence there will be a ſtrong attraction between them, for the reaſon before-mentioned, till, on a nearer approach, a ſpark proceeds from the former to the latter, which reſtores the equilibrium as before.

Hence likewiſe the reaſon is evident, why two bodies that are both equally electrified, either negatively or poſitively, will never receive a ſpark one from the other, the repulſion being equally exerted in both.

Exp. 3. If a perſon be inſulated, by ſtanding on a board with glaſs ſupporters, and preſents his knuckle to the electrified conductor, (the motion of the machine being ſtopped at that time) he will take only part, though the greateſt part, of the fluid from it; the whole charge being divided between them, proportionably to their quantity of ſurface, and both the perſon and the conductor will afterwards give a ſmall ſpark to another body preſented.

Exp. 4. If a piece of metal, or a conductor, of the ſame ſize as that which is electrified, be inſulated and preſented to it, the electricity will be equally divided between them, and both of them will afterwards produce a ſpark equally ſtrong.

Exp. 5. The larger the conductor is, the greater will be the quantity of matter compreſſed on it, and of conſequence the ſtronger will be the ſpark that may be taken from it: Therefore, if a perſon ſtanding on the board before-mentioned, holds in his hand a wire or chain communicating with the electrified conductor, he may be conſidered as a part of it, and a much ſtronger ſpark may be drawn from him, by another perſon on the floor, than could be done from the conductor alone; and both will be equally ſenſible of the force of it.

Exp. 6. Let the perſon ſtanding on the board, hold in his hand a ſpoon with a little brandy, or ſpirit of wine in it, (firſt warmed over a fire) and another perſon on the floor, apply his knuckle, or the end of a diſcharging rod, quickly towards the ſurface of it, and it will inſtantly be in a flame: the ſame may be done, if the perſon on the floor holds the ſpoon,—the ſpirit may then be fired by the electrified perſon.

Exp. 7. The above experiment may be agreeably varied in the following manner;—The electrified perſon on the board holding the ſpirits, as before, let a perſon ſtanding on another inſulated board, or on a cake of wax, hold in his hand an iron poker, one end of which is made red hot; he may then apply the hot end to the ſpirits, and even immerge it in them, but they will not take fire; but, if he puts one foot on the floor, he may then ſet the ſpirits on fire with either the cold end or the hot, provided the latter be not worn to too ſharp a point. An iron rod, with a knob at each end, is moſt proper for this purpoſe.

The reaſon why the ſpirits could not be kindled by the perſon when inſulated, is becauſe the electric fluid cannot eſcape through him to the earth, he is therefore incapable of drawing a ſpark ſufficiently ſtrong to inflame them; and hot iron immerſed in ſpirits, will ſeldom

dom or never ſet them on fire. When they are inkindled by the electric ſpark, it is undoubtedly effected by the rapid and violent action of the fluid, in its paſſage from the ſurface of the ſpirits, through the inflammable vapour ariſing from it. A candle that is newly blown out, may alſo be rekindled by a ſtrong electric ſpark, (every electric exploſion diſplacing a quantity of air around it)—but this may be perform'd much eaſier by a breath of air from the mouth.

Exp. 8. Take an iron poker, or a bar of any metal, and make it red hot in the middle; let one end reſt on the prime conductor, while the other is ſupported by a glaſs ſtand; in theſe circumſtances an electric ſpark may be drawn from any part of the poker, from the ignited place as well as from the two ends. A *magnet* may alſo, at the ſame time, be hung to the poker,—it will attract, and be attracted by the iron, the ſame as though it was not electrified. This may ſhew that *magnetiſm* is not affected by *electricity*, nor electricity by *fire*; neither does it appear that the laſt is any way concerned in theſe operations.

SECT. V.

Of Electrical Attraction *and* Repulsion.

THESE appearances have been ſubject to the enquiries of very learned and ingenious men. We find the names of Boyle, Hales, Hawkesbee, Franklin, Canton, among many others, of our own countrymen; and of Æpinus, Beccaria, Nollet, Wilcke, with other ingenious foreigners, to whoſe laborious reſearches and fortunate diſcoveries the world will ever remain indebted, and which have rendered their names illuſtrious in the annals of ſcience. Moſt of them eſpouſed their favourite *Theories*, which, in ſome points, widely differed from each other; but this was one reaſon that the progreſs of electricity, when thoſe gentlemen were earneſtly engaged in examining and correcting each other's *hypotheſes*, appeared to be ſo rapid.

The electricians in *England*, *France*, *Germany*, and other parts of Europe, and in America, imparted their diſcoveries to each other with a freedom that did honour to the advocates of ſcience. Truth, more or leſs clear, is generally the reſult of a liberal enquiry. Accordingly ſeveral facts were diſcovered that were truly amazing, and which afterwards aſtoniſhed the greateſt part of Europe, where they were exhibited; every one being eager to behold experiments that appeared to be rather a kind of *magic* than the reſult of philoſophy.

The Electricians themſelves ſeemed to be ſomewhat puzzled in attempting to account for the appearances of *electrical attraction and repulſion*;—and it muſt be owned that they have not here been quite ſo fortunate in their elucidations, as to free the ſubject entirely from obſcurity: In ſome inſtances, indeed, demonſtration can ſcarcely be expected, and where we cannot be admitted to abſolute proof, we muſt be ſatisfied with ſuch concluſions as appear to be moſt rational and conſiſtent.

Of all the opinions that have been hitherto adopted, concerning electricity, that of Dr. Franklin, bebefore recited, appears to have obtained the moſt general aſſent; not only becauſe it is acknowledged to be the moſt probable, but becauſe it may be extended to every electrical phænomenon, and is capable of ſolving every appearance, that admits of ſolution, in a more ſatisfactory manner than any other: So that, like the *Newtonian* PHILOSOPHY, it now almoſt ceaſes to be merely an *hypotheſis*.

EVERY one who has been converſant with electricity, will acknowledge that there are ſome appearances in this ſpecies of attraction and repulſion, which are not readily and preciſely to be accounted for, from the poſtulata of any of the received *theories* of electricity. But, in attempting to account for *any* appearance, it is neceſſary that *ſome* theory ſhould be kept in view, or we are not likely to draw many ſatisfactory concluſions: And it is certain, that thoſe inferences have hitherto been liable to the feweſt objections, that have been drawn from the principles of Dr. FRANKLIN.

EXP. 1. TAKE ten or a dozen ſmall downy feathers, and tie each of them ſeparately to a fine linen thread; let the whole be then tied to the end of a ſmall metal rod. The length of the rod is of no conſequence,—the threads may be about an inch and half in length. If the end of the rod be inſerted into the prime conductor, upon ſetting the machine in motion, the feathers will immediately expand, and, avoiding each other, will ſtand at the greateſt poſſible diſtance. The feathers receiving from the conductor a greater quantity of the electric matter than is natural to them, their *atmoſpheres* (as it is ſometimes called, tho' perhaps improperly) repel each other.[h] At the ſame time, if the hand, or any other non-electric, be made to approach them, they will all be ſtrongly attracted to it.[i] The hand being in its natural ſtate, or rather, acquiring a ſmall degree of a contrary electricity, attracts, and is attracted by the abounding quantity of matter in the feathers.

EXP. 2. IF the feathers be connected to a conductor electrified *negatively*, the ſame appearances will enſue

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[h] Ax. 5. [i] Ax. 8.

as in the foregoing experiment. The feathers will appear to be repelled from each other,[k] and attracted by any other body.

WE cannot ſo eaſily conceive why two bodies that are *negatively* electrified ſhould repel each other, as we can when they are electrified *poſitively*. It is ſuppoſed that, ‘ when two or more bodies are exhauſted of their ‘ natural ſhare of electricity, they are attracted by the ‘ denſer fluid, exiſting either in the atmoſphere con‘ tiguous to them, or in other neighbouring bodies; ‘ which occaſions them ſtill to recede from one another, ‘ as much as when they were overcharged.’ Others have ſuppoſed it to be rather owing to ‘ an accumulation ‘ of the electric fluid on the ſurfaces of the bodies; ‘ which accumulation is produced by the attraction of ‘ the bodies, and the difficulty the fluid finds in en‘ tering them. This difficulty in entering is ſuppoſed ‘ to be owing, chiefly, to the *air* on the ſurface of ‘ bodies, which is probably a little condenſed there.’

PERHAPS the apparent *repulſion* of bodies electrified either *negatively* or *poſitively*, is occaſioned rather by the attraction of other bodies ſurrounding them, and the humidity of the *air*, than by the repulſion of any electric *atmoſpheres* that may ſurround the electrified bodies. I am the rather of this opinion from the following obſervations—When the feathers, before-mentioned, are placed in the middle of a large electrified ſurface, ſuch as a board three feet ſquare, their repulſion of each other will appear very languid, to what it will if they are placed at the *edge* of the board, ſo as to be more immediately within the attraction of unelectrified bodies. If a ſingle feather, or a piece of down, be placed near the edge of the board, it will immediately fly off to the neareſt body that is unelectrified; but, if placed in the middle of the board, it will be a conſiderable time before it will move, and ſcarcely ſhew any ſigns of repulſion till another body be held over it, the feather will then immediately fly to it.—When the bunch of feathers is ſet up on the board, and covered with a large glaſs recipient, they will hardly be repelled at all, or, if they are, they ſoon collapſe; when the recipient becomes a little electrified, a ſpark taken from the prime conductor will make the feathers expand, being attracted by the electricity of the glaſs.—If an *air-pump* be placed on the electrified board, and the rod of feathers ſet up in the exhauſted recipient, I never found them to ſhew any ſigns of electricity, till the hand, or ſome other body, approached the glaſs, they would then be attracted to it. The effects will be the ſame, in theſe experiments, whether the electricity be poſitive or negative.

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[k] Ax. 6.

EXP. 3. THE feathers being expanded with either electricity, if a pointed wire, or a pin be preſented towards them, it immediately makes them collapſe and ſhrink together; the point drawing off the electric matter, they become unelectrified, and are therefore ſuddenly attracted by the electricity of the conductor. If the point be preſented to any part of the conductor, the effect will be nearly the ſame.

EXP. 4. LET the pointed wire, inſtead of being held in the hand, be fixed to any part of the conductor, with the point outward; upon turning the machine, the feathers will be electrified but very feebly, riſing gradually, as though the quantity of electric matter was very ſmall; the point throwing moſt of it off into the air.[1] If the feathers are fixed to the *negative* conductor, the effects will be the ſame, but the cauſe reverſed.

EXP. 5. LET two very ſmall balls of cork be faſtened to the ends of two threads, about ſix inches in length.

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[1] Ax. 12.

length. If theſe be held in the hand near the electrified conductor, they will be ſtrongly attracted to it, and repelled from each other. The electricity of the conductor repelling the natural quantity from the balls, through the threads, to the hand that holds them, they become *negatively* electrified, and therefore avoid each other, at the ſame time that they are attracted by the *poſitive* electricity of the conductor. But, if the balls are held towards a conductor *negatively* electrified, they will diverge with *poſitive* electricity, this being drawn from the hand, through the threads, to the balls.

EXP. 6. LET a circle or hoop be made of thick braſs wire, 12 or 14 Inches diameter, to which tie 6 or 8 fine threads, at equal diſtances from each other. Let the ſame number of threads be faſtened to another ſmaller hoop, of a ſize juſt fitting the prime conductor, ſo as to go on the end of it. The threads are all to be of an equal length, and of ſuch a length as, when the ſmaller hoop is placed in the centre of the larger, and the threads from each extended toward one another, their ends may reach each other within a quarter of an inch, forming ſo many diameters to the hoop, like the ſpokes of a wheel.—Put the ſmall hoop on the end of the conductor, and, when the machine is in motion, the threads will all be extended in right lines. If the larger hoop be then vertically fixed on a glaſs ſtand (with a chain hanging from it to the table) ſo as to form a circumference to the other, the threads on both will be attracted, and the ends point to, and nearly meet each other.

THIS experiment has been admired as curious, but is readily accounted for, on the theory of Dr. FRANKLIN.—The threads on either hoop become poſſeſſed of an electricity contrary to each other; thoſe on the ſmall hoop have a *redundancy* [m] of the electric matter, and thoſe on the larger a *deficiency*;[n] they are, conſequently, ſtrongly attracted to each other. The electric matter flies off from the threads of the ſmall hoop, is received by thoſe on the larger, from which it is conveyed, thro' the chain, down to the table, &c. If the chain be taken away, the larger hoop will be inſulated—the threads on it will firſt be attracted as before, to thoſe on the ſmaller, till becoming charged with a *poſitive* electricity, they will immediately be repelled, and avoid the others: Thus they may be made to attract or repel, at pleaſure, by touching the large hoop with a non-electric.—This is an entertaining experiment, but requires ſome degree of attention to make it ſucceed properly;—the following is on the ſame principle, and is more eaſily managed.

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[m] The *poſitive* electricity is always ſuppoſed to be made uſe of, unleſs the contrary is mentioned.

Exp. 7. Let a ſingle thread be ſuſpended from the prime conductor, five or ſix inches long, under which let another thread, of the ſame length, be faſtened to any thing on the table, ſo that the end of it, when extended, may nearly touch the end of the thread from the conductor. Upon turning the machine, the two threads will be attracted, and point to each other, as in the laſt experiment. If any non electric (as the round knob of a diſcharging rod) be made to approach the ends of the threads, when ſo attracted, it will repel the lower thread, and attract that which is connected with the conductor.

The end of the diſcharging rod being electrified negatively by the upper thread, immediately attracts it, and, for the ſame reaſon, repels the lower thread, which is likewiſe in a negative ſtate. But, if the end of the rod be brought to the *lower part* of the undermoſt thread, ſo as to be *out of the influence*, or atmoſphere of the upper one, the under thread will be immediately attracted by the rod.

We may have an agreeable proof of this *negative ſtate* of the lower thread in the following manner,—

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[n] Ax. 9.

Take a ſmall coated phial, with a thick wire, communicating with the inſide, faſtened by a cork, in the neck of the phial; electrify the inſide of it *negatively*;[o] if the wire of the phial be then brought near the ends of the threads, we ſhall find the effects to be the ſame as when the diſcharging rod was applied,—the upper thread will be attracted, and the lower one repelled. But, if the phial be electrified *poſitively* on the inſide, and the wire brought to the threads as before, the appearances will now be directly contrary—the upper thread will be repelled, and the under one attracted.

Exp. 8. Let a diſcharging rod with a braſs knob at each end, be fixed upon a glaſs ſtand, or ſome other electric, and one of the knobs be placed within an inch and a half of the prime conductor, the other, at the fartheſt poſſible diſtance from it: That end of the rod near the conductor will then be within the influence of its electricity, whereby the electric matter natural to the rod, will be repelled to the other end; ſo that one end will be electrified negatively, and the other end poſitively.

In order to prove this, Take the ſmall coated phial, and, on the wire that communicates with the inſide, fix a ſmall downy feather. Charge the phial poſitively on the inſide: The fibres of the feather will then expand, and be attracted or repelled according to the quality of the electricity that it approaches.[p] Holding the phial by the coating, preſent the feather to any part of the prime conductor, and it will be repelled; if the feather be preſented to that knob of the rod which is neareſt to the conductor, it will be attracted to it; but, if it be brought to the other knob, it will be again repelled, as at the conductor, but not ſo ſtrongly, becauſe the electricity of the rod is not ſo ſtrong. Change the electricity of the phial, and all the appearances will be changed; If it be electrified negatively on the inſide, the prime conductor will attract the feather, as will likewiſe the knob of the rod that is remote from it, but the knob near the conductor will be found to repel the feather. This, and the preceding experiment, ſeem to be pretty clear proofs of the 9th axiom, which was a diſcovery firſt made, I believe, by the late ingenious Mr. CANTON, and afterwards illuſtrated in a variety of experiments by Dr. FRANKLIN, Mr. WILCKE, ÆPINUS, and others; on which principle many appearances of electrical attraction and repulſion are eaſily accounted for, which would otherwiſe be enveloped in obſcurity.

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[o] Ax. 11.

[p] Ax. 5, 6.

EXP. 9. WHEN any ſubſtance is once electrified, and thoro'ly inſulated by good electrics, that ſubſtance will not readily part with the electricity it has received, till it has touched ſome other body that is unelectrified. For this reaſon, if a light piece of cotton, or a downy feather be brought near an excited glaſs tube, it will firſt be attracted to it, till it be replete with the electric matter of the tube; being then electrified poſitively, it will recede from the tube, and be driven into the air, (where it may be ſaid to be inſulated, the air, when free from moiſture, being a very perfect electric.) A perſon with the excited tube in his hand, may drive the feather about in what direction, or to what place he pleaſes, for it will ſtill fly from the approaching tube, till it has loſt all its redundant electricity; or two perſons with each of them a tube, may drive it from one another like a ſhuttlecock. This experiment, if there be a little dexterity in the management of it, proves very amuſing, and indeed, would appear very aſtoniſhing, but that the effects are always the ſame, and the cauſe ſufficiently apprehended.

EXP. 10. THE ſtrong tendency of electrified bodies to avoid each other, and to attract bodies unelectrified, is the immediate cauſe of all the diverſity of appearances that we ſee in the various experiments of electrical attraction and repulſion;—This may be ſimply repreſented in the following manner—Take a ſmall cork ball, a piece of cotton, or any other light body, and tie it to the end of a ſilk line; ſuſpend it about two inches from the ſide of the prime conductor, and hold the palm of the hand at the ſame diſtance from it, ſo that it may hang in the middle, between the hand and the conductor: If the machine be then worked, the ball will be attracted to the conductor, and, being immediately loaded with the electric matter, will as ſoon be repelled from it, or attracted by the hand, which, receiving from it its ſmall quantity of electricity, it will then be attracted and repelled between the hand and the conductor with ſurpriſing rapidity.

Exp. 11. The ringing of *electrical bells* is explained on the ſame principle.—Three ſmall bells being hung to a rod of metal, about an inch diſtant from each other, the two at the ends by a braſs chain, the middle one by ſilk—between each bell, a very ſmall piece of metal, ſuſpended alſo by ſilk, as clappers. Theſe being hung to the conductor, the clappers will ſtrike the bells very forcibly. The two outward bells, being ſuſpended by chains, become electrified, and attract the clappers, theſe, receiving the electric matter, are immediately repelled from them, and attracted by the middle bell, whereon they diſcharge their electricity, which is conducted off to the ground, by means of a chain fixed to the bottom of that bell.

Exp. 12. Let a plate of metal, ſix or ſeven inches diameter, be ſuſpended by wires, or chains, from the prime conductor—another plate, nearly the ſame ſize, placed about four inches below it, upon any conducting ſubſtance.—If feathers, pieces of paper, or any other light ſubſtances, are put on the under plate, they will be attracted and repelled from one plate to the other with prodigious ſwiftneſs. A piece of thin paper (or rather a bit of leaf gold) cut in the form of an acute angle, or ſharp at one end, and wide at the other, will frequently be ſuſpended, for a conſiderable time, between the two plates, without touching either.

A GREAT variety of other entertaining experiments may be performed by electrical attraction and repulſion, which, with a little invention, the young electrician may adapt to his own purpoſe or fancy; every variation, in theſe experiments, not only facilitates the *practical* part, but has alſo a tendency to render the *theory* more perſpicuous.

SECT. VI.

Experiments made by the Blaſt iſſuing from the POINTS *of* ELECTRIFIED BODIES.

FROM the ſharp edges or points of bodies electrified either poſitively or negatively, there is always a ſenſible wind, occaſioned, perhaps, by the precipitate retreat of the electrified particles of *air* near thoſe points, where the electric matter is greatly condenſed, both in its entrance and exit from them.

IT is ſomewhat remarkable that this current of air is the ſame, whether the point be *imbibing* or *throwing off* the electric fluid. If a ſharp-pointed wire be projected from a conductor, either poſitively or negatively electrified, it will ſometimes blow a blaſt ſufficient to extinguiſh a candle held before it, and equally ſtrong from either electricity: Or, if the point be held in the hand, and preſented to the conductor, it blows nearly the ſame;—if it be held oppoſite to another point on the conductor, they will both blow againſt each other, but the point in the hand not ſo ſtrongly as that of the conductor.

To a perſon poſſeſſed of a little ingenuity, or a turn for mechanics, it needs only be intimated, that there is a blaſt or current of air iſſuing from the points of wires, turned in any direction, and he will immediately perceive how great a variety of appearances and movements may be effected by means of this *primum mobile:* He will very ſoon find himſelf able to apply it to the purpoſe of turning ſmall paper vanes, made in diverſe forms, and to make theſe communicate motion to a variety of engines in miniature, &c.—but to be explicit in theſe effects of electricity, would be deviating too much from my preſent deſign, which is rather to promote its utility than its divertiſement.

THE ingenious Mr. JAMES FERGUSON, whoſe invention is ſeldom at a loſs in blending agreeable entertainment with philoſophy, has invented and made a variety of little curious machines of this kind, whoſe movements are effected by the blaſt of air from electrified points. I muſt refer the reader to his book entitled, *An Introduction to Electricity* for a particular deſcription of his *electrical orreries*, *clocks*, *water-mills*, *pumps*, &c. which will afford much entertainment to thoſe who can reliſh innocent domeſtic amuſement. The ſcience of electricity, as well as many others, is undoubtedly indebted to this gentleman; for, to render any ſcience familiar and agreeable, is to render it prevalent, and the more it prevails in practice, the more likely it is to produce uſeful diſcoveries.

I SHALL therefore juſt mention one or two experiments, which the electrician may vary and improve at his leiſure.———When any points are electrified, ſo as to emit a ſtrong blaſt, the re-action of the air forces them backward, or gives them a tendency to move in a contrary direction; ſo that if a ſmall wire be bent at the ends, and each point be made to have a direction oppoſite to the other, and then nicely poiſed on the point of another wire, on which it may freely turn, as a centre, when theſe wires are ſet up on the electrified conductor, the bent wire will be found to turn round like the fly of a jack—the points will alſo be illuminated, and, in the dark, will appear like a circle of fire.

WHEN I firſt ſaw this experiment, I was rather at a loſs to determine whether the turning of the wire was effected merely by electricity, or by the re-action of the air on the points; I therefore electrified the wire *negatively*, ſuppoſing that, if electricity was the cauſe of it, as the fluid was now *entering* the points, the wire would either turn the contrary way, or elſe not turn at all; but, finding it turned juſt the ſame as it did before, I concluded it to be ſolely owing to the reſiſtance of the air; but, in order to be farther ſatiſfied, I faſtened two ſmall glaſs *eolipiles* to the ends of a light rod of wood, their orifices, which terminated in a capillary tube, in oppoſite directions to each other: Under the eolipiles were fixed two ſmall lamps, and the whole ſuſpended by a thread in the centre. When the lamps were lighted, and the eolipiles ſufficiently heated to emit a current of air, the apparatus began to be in motion, and ſoon afterwards turned round pretty ſwiftly.

I ELECTRIFIED the wire fly in the exhauſted receiver of an air-pump, but found it would not turn at all—and but very ſlowly, if covered with the receiver, without exhauſting, unleſs the hand was made to touch the glaſs; it might then be made to turn by the electric attraction, in any direction, either with the points foremoſt or the contrary. But this operation, if it be continued for any time, will charge the glaſs recipient very ſtrongly with the electric matter, and, if the hand be put into it, while the other is oppoſite to it on the outſide of the glaſs, an exploſion will frequently be produced, and the perſon receive a ſmart ſhock.

If the wires are inſulated, and placed near an electrified body, or even held in the hand, they will turn round very ſwiftly, but if they are placed near a glaſs cylinder in motion, they will be turned with ſo great rapidity as entirely to diſappear, except in the dark, when a beautiful luminous ring will be viſible.

If ſmall boats are made of cork or light wood, and floated on electrified water, they may be attracted and made to ſwim in any direction, by applying a finger towards them; a fine needle ſtuck into the end of the boats, in the manner of a bowſprit, will cauſe them to be repelled from the hand, held over it, and they may be ſteered by it, ſtern foremoſt, to what point of the compaſs you pleaſe. The boats might have the addition of ſails to them, and might then be made to ſail very briſkly before an electrical gale, from the point of a wire held in the hand.

The operator in theſe tricks, would certainly be looked upon as a magician, if the electrical machine was kept out of ſight: But a ſtill more ſtriking appearance, would be a number of theſe boats, with each of them a twirling wire fly, about an inch in length, fixt to the top of the maſt; the hand held over them, would ſet them all in motion, which, in the dark would appear as ſo many rings of fire, moving in various courſes, and following the hand in any direction.

When a few young perſons have nothing elſe to do, they might very innocently amuſe themſelves by making a repreſentation of a kind of ſea-engagement between theſe boats—ſuppoſing each of them to be large enough to hold a ſmall coated phial without ſinking; theſe phials may be charged, ſome of them poſitively on the inſide, others negatively; they may then be placed at the bow of the boat, with the wire (which ſhould have a very ſmall braſs ball at the end of it) and the uncoated part of the phial, projecting over; a ſmall braſs chain ſhould be made to touch the outward coating of the phial, and the other end brought over the ſtern of the boat, and hang ſo as to touch the water. The boats being then put into a trough of water, and the phials pretty highly charged, they will ſoon be in motion; thoſe that are electrified alike, will repel each other, and thoſe poſſeſſed of a contrary electricity will be attracted, till the balls of the two phials approach pretty near together, they will then diſcharge their contents with a loud exploſion, and the boats afterwards ſheer off from each other.

SECT. VII.

Of Charging COATED GLASS.

WE are now to conſider the electric fluid in a ſtate of compreſſion, in which it will appear to be a much more formidable agent, than in the preceding experiments.

IT is well known that *air*, when condenſed, will act with a prodigious force. Upon turning the ſtop-cock of the veſſel that contains it, it will ruſh out with a violence proportionable to the degree in which it was compreſſed. This force would be greatly increaſed if, (inſtead of the air diſcharging itſelf into the common atmoſphere) upon turning the ſtop-cock, it was made to paſs into a *vacuum*, or another veſſel out of which the air had been exhauſted. The air is ſuppoſed to acquire this ſpring, from the repulſive power of its particles, each repelling, or endeavouring to recede from the other; ſo that the more they are compreſſed, or forced cloſer together, the greater will be their reſiſtive force. The electric fluid is of a nature ſtill more elaſtic than the air, and its particles more ſtrongly repulſive of each other; for which reaſon, if a quantity of it be condenſed on one ſide of a pane of glaſs, and, at the ſame time, the other ſide be equally exhauſted, the efforts made by it to reſtore the equilibrium muſt be very conſiderable.

We may purſue the parallel, by ſuppoſing the exploſion of a charged glaſs phial (which is made by forming a communication from one ſide to the other, by means of conducting ſubſtances) to be ſimilar to the turning of the ſtop-cock which ſeparates the condenſed air from the vacuum,—the effects of either, will be a rapid tranſition of the fluids to their natural ſituation.

Neither the form nor ſize of the glaſs is of any conſequence, with reſpect to its becoming *charged* with the electric matter. A pane of common window-glaſs, with either leaf-gold, tinfoil, or any other non-electric ſubſtance, placed in contact with both its ſides, is capable of being charged as well as a glaſs phial, or jar, provided a margin of the bare glaſs, at leaſt an inch in breadth, be left all round it. Other electric ſubſtances, different from glaſs, are alſo capable of becoming charged, as a plate of *ſealing-wax*, *ſulphur*, *baked wood*, and even the *air*, acting as other electrics, will keep aſunder, for ſome conſiderable time, the *plus* electricity from the *minus*.

In order to charge a pane of coated glaſs, or a phial, we connect one ſide of it, by means of conducting ſubſtances, to the prime conductor, while the other ſide is connected with the earth. The electric matter then paſſing from the conductor to the *inſide* of the glaſs, (ſuppoſing it to be a phial) electrifies that ſide poſitively, and, at the ſame time repels an equal quantity of the fluid from the *outſide* of the glaſs, which is driven back to the earth; by this means, one ſide of the glaſs becomes exhauſted, and the other redundant, or, in other words, one ſide is electrified *negatively*, and the other *poſitively*.

A phial will remain in this ſituation, when ſet upon electrics, for 12 or 24 hours, or perhaps, much longer, if the air be dry, and no conducting ſubſtance approaches it; but, if one end of a diſcharging rod be apply'd, firſt to the outſide of the phial, and the other end brought to the wire that communicates with the inſide, a ſtrong exploſion will immediately enſue, and the glaſs be inſtantly reſtored to its natural ſtate. The perſon who makes the exploſion in this manner, will not be affected, or in any meaſure ſenſible of the diſagreeable ſenſation uſually termed a *ſhock*, as the matter all paſſes through the diſcharging rod; but, if he applies the rod to the wire, or any part of the conductor in contact with it, before he touches the outſide of the phial, he will receive a great part of its contents through him, and feel a ſharp, pricking pain, as though he was cut with a keen inſtrument, and the phial will ſtill remain partly charged. If the diſcharging rod, or the hand, be brought to the wire of the phial, while the other hand touches the outward coating, all the matter will paſs through the perſon's arms and breaſt, and he will be ſenſible of a ſmart ſhock. A chain being fixed to the outward coating of the phial, and the other end of it made to touch the floor, a perſon ſetting his foot on this chain, and then applying his hand to the conductor, he would be ſenſible of the ſhock both in his hand and foot, and, if it be a very large phial, all over his body; the fluid paſſing entirely through him, from the conductor, up the chain, to the outſide of the phial.

If a charged phial be ſet upon electric ſubſtances, it may be taken hold of, without danger, either by the coating or the wire; no more than a ſmall ſpark will iſſue from one or the other; in this manner, by alternately touching the wire and outſide, it may be totally diſcharged without any exploſion.

IN the diſcharge of a phial, the electric matter is always found to paſs through the beſt conductors, more readily than through conductors that are leſs perfect, though the circuit, in the former caſe, may be much longer. It will go through a hundred yards of wire, or chain, rather than through half as many inches of wetted packthread, (ſuppoſing the diſcharge to be made through both at the ſame time) a ſmall quantity of the fluid, however, would be found to paſs through the packthread.

IF the diſcharge be made through conductors equally perfect, but of unequal lengths, the greateſt part of the fluid will paſs through the ſhorteſt; as, ſuppoſing the exploſion to be made through two different circuits, one of them formed by two perſons, joining hands, the other by a perſon ſingly—they would all feel the tranſition of the fluid, but the two, not ſo violent as the ſingle perſon.

IF a circuit be formed by any number of perſons joining hands, on the diſcharge of the phial they will be all ſhocked with equal violence, and at the ſame inſtant of time; but the violence of the ſhock to each perſon, will not be ſo great, ſuppoſing them to be twenty or more in number, as it would if there were only three or four.

EXP. 1. TAKE a ſmall coated phial, with a hook to the wire that communicates with the inſide, and ſuſpend it on ſome part of the prime conductor, (for which purpoſe, and for ſeveral others, it is convenient that the conductor be furniſhed with ſome braſs rings) though the machine may act very ſtrongly, yet the phial, in this ſituation, cannot be charged; the reaſon of which is, becauſe little or none of the electric matter can eſcape from the outward coating, and therefore no more can be thrown into the inſide than that which is equally condenſed on the conductor. But the outſide of the phial will be found to be electrified, and will yield a ſpark to any non-electric that approaches it; if ſparks are repeatedly drawn from it, the phial will become charged; as much of the electric matter as is taken from the coating, ſo much will be compreſſed on the inſide, till the phial is fully charged.

If a ſharp-pointed wire be fixed on, and made to project from the coating, it will carry off the fluid from it, and the phial will become charged; or, if a point be held at the diſtance of three or four inches from the phial, it will likewiſe charge, the point, in this caſe, imbibing the fluid from it.

As the phial cannot become *charged*, unleſs the electric matter be conveyed from one ſide by means of conducting ſubſtances, at the ſame time that the other is receiving an equal quantity, ſo likewiſe it cannot be made to *explode*, but by means of metallic, or ſome other good conductors, forming a channel conveyance from one ſide to the other; for, as the fluid cannot paſs through the glaſs,[q] on account of its being a non-conductor, one ſide muſt therefore remain exhauſted, in the ſame proportion as the other ſide is redundant, notwithſtanding the power of attraction between them is ſo very great, and having no other *barrier*, to ſepa-

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[q] It has been objected that, if the glaſs be ſuppoſed to be impermeable to the electric fluid, there ariſes a difficulty in conceiving the manner in which it exerts its attractive and repulſive powers through the glaſs. This *impermeability*, if we conceive it to be no more than a *reſiſtance* of the fluid's paſſage, is not peculiar to *glaſs*, it is common to all other electric ſubſtances, which reſiſt the paſſage of the fluid in proportion to their quality of being more or leſs perfect: But it is certain that

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rate them, than the thin ſubſtance of the glaſs. This *thinneſs* of the glaſs is, indeed, the cauſe of the attraction being ſo ſtrong, as it admits of the moſt affecting proximity, without an abſolute contact. For this reaſon, the thinner a phial is blowed, in the making, the higher will be the charge it is capable of receiving; but it will be ſo much the more ſubject to a ſpontaneous exploſion; if it be too thin, the force of a ſtrong charge will frequently break the glaſs, perforating a ſmall hole, and ſometimes two or three, through the glaſs and coatings; the glaſs appearing to be pulverized, a conſiderable ſpace round the hole.

Exp. 2. Take two ſmall coated phials, and charge them *poſitively*, on the inſide; let them be ſuſpended, by their hooks, to the prime conductor: The diſcharging rod may then be applied to the outward coating of each of them, ſo as to form a communication, but there will be no exploſion; the coating of both being electrified in the ſame manner, [*negatively*] neither of them has any thing to communicate to the other. The phials may be taken off the conductor, and the wires of each brought together, with no more effect than before; but, was a perſon to hold one of the phials by the wire, and the other by the coating, and bring the coating of the one to the wire of the other, there would immediately be an exploſion, and the perſon would be ſenſible that the charge of both had paſſed through him.—If one of the phials was to be electrified poſitively

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this reſiſtance, even in the moſt perfect electrics that we know of, is not ſufficient to prevent the attractive influence, or effect of the fluid upon bodies brought to a certain degree of vicinity; and it is as clear, that this action of the fluid, whatever be the cauſe, is not effected by its *paſſage through* the electric. It is, perhaps, as difficult to form a perfect idea of the mode of action which, in this inſtance, ſeems peculiar to the electric fluid, as it is to conceive the primary cauſe of gravitation, magnetiſm, or any other ſpecies of attraction and repulſion.

tively, and the other negatively, both being ſuſpended to the conductor, and the diſcharging rod applied as before, to the outſide of each, the electric matter would ruſh with violence from one to the other, through the rod, and both the phials be diſcharged.

Exp. 3. A person ſtanding on the glaſs-legg'd board, before mentioned, (when connected with the prime conductor, by means of a chain, or metal rod) and holding in his hand a ſmall phial, if he preſents the wire of it to another perſon, ſtanding on the floor, the phial will become negatively charged on the inſide, the fluid having paſſed from thence to the earth, through the perſon who ſtood on the floor; let the phial be then delivered into the hand of the perſon on the floor, who, taking hold of it by the coating, may preſent the wire to him on the board; by this means there will be thrown into the inſide of the phial, a quantity of the fluid ſufficient to reſtore the equilibrium, and, if the motion of the machine be ſtopped in proper time, the phial will be found to be in its natural ſtate, or entirely diſcharged, without any exploſion.—This experiment may be performed by one perſon, who, holding the phial by the wire, may preſent the outward coating to the conductor, by which means the phial will become charged as before, viz. negatively within, and poſitively without; when it is charged, let him ſet it down on glaſs, or ſome other electric, and, taking hold of it by the coating, preſent the wire to the conductor, and the phial will be gradually diſcharged:—Or, if the rubber of the machine be inſulated, he may preſent the wire of the phial to the conductor (counting the number of revolutions of the wheel) till it be charged; then, holding the wire to the rubber, the ſame number of revolutions will diſcharge the phial.

These experiments may be varied many ways, by electrifying the phials, ſometimes poſitively, and then negatively, both at the prime conductor and at the rubber, or negative conductor; by which means any one may very ſoon perfect himſelf in the theory and nature of electric circuits.

Exp. 4. Take a common phial bottle, thoroughly dry, and fill it about two thirds full of quickſilver, ſteel-filings, or leaden-ſhot; let a wire be then inſerted into the neck of the phial, ſo as to touch the ſhot; if the lower part of the phial be graſped in the hands all round, and, at the ſame time, the wire applied to the electrified conductor, the glaſs will become charged, and capable of conveying an exploſion or ſhock, the ſame as though it was coated: The ſhot may be poured out of the phial; but though it be poured into a glaſs veſſel, it will ſhew little or no ſigns of electricity; nevertheleſs, the phial will ſtill remain ſtrongly charged:—In order to prove this, pour the ſhot into it again, and graſp the lower part of the phial as before, then, upon inſerting the wire into it, a convincing proof will follow. This evidently ſhews, that the force of a charged phial is not contained in the non-electric coating, but in the glaſs itſelf. It is ſurpriſing to find how large a quantity of the electric matter is capable of being compreſſed in a ſmall quantity of glaſs; an ounce phial, blown very thin, may be made to contain a charge as ſtrong as a man can well bear.

The force of an electric exploſion ſeems to depend more on the heighth of the charge, or degree in which the fluid is compreſſed, than on the quantity of it. A quart phial, when fully charged, will act nearly with as great force as a phial containing a gallon, when no more than half charged: The exploſion will likewiſe be as loud, and the ſenſation or ſhock, more ſmart and pungeant. Several reaſons might be aſſigned for this; the chief cauſe, perhaps, is the fluid being much leſs condenſed, in proportion to its quantity, it cannot acquire ſo great a ſpring, or elaſtic force, and, poſſibly, its velocity is alſo diminiſhed in a certain ratio: A large phial muſt be blown thicker, in the making, than a ſmall one, whereby the power of the charge will be decreaſed.

NEARLY double the electric force may be obtained from four phials, containing a quart each, as from one gallon phial; not only from their being more thin, but becauſe they be made to contain a much greater quantity of coated ſurface. The *bottom* of a phial, though coated, by reaſon of the thickneſs of the glaſs in that part, adds very little to the ſtrength of the charge, and therefore ſhould not be included in calculating the quantity of coating.

IN charging of phials, much depends on the goodneſs of the machine, and the force with which it acts. Every machine has a certain degree of force, and is capable of fully charging a certain number of phials, which has been properly called the *maximum* of its power, beyond which it cannot go, though the motion be continued. If the number of phials exceeds the power of the machine, they will never be fully charged. The greater is the quantity of fluid compreſſed in a phial, the greater will be its reſiſtance of receiving more: ſo that when the reſiſtance becomes equal to the power of the machine, the fluid will have as ſtrong a tendency to fly off from the pointed wires that collect it, as the cylinder of the machine has to throw it on. For this reaſon, if a machine be capable of fully charging no more than two phials, though twenty be connected with it, they will produce no ſtronger an exploſion than the two.

EXP. 5. A VERY curious experiment, in order to ſhew the nature of charging electric ſubſtances, may be made with a pane of glaſs, about a foot ſquare, coated on each ſide with tinfoil, within two inches of the edge. But a form more convenient for holding in the hand, would be a circular piece of glaſs, with a kind of handle, in the form of a battledore.—Two ſmall wires, about two inches in length, may be made to project from the centre of the coating, one on each ſide—they may be eaſily fixed on with ſealing-wax, ſo that one end of the wire may touch the tinfoil. By this inſtrument, the direction or courſe of the electric fluid, as the glaſs is charging, may be rendered viſibly evident, in a dark room. If the machine acts pretty ſtrongly, upon holding the glaſs in the hand, and applying the end of one of the wires within half an inch of the end of the prime conductor, that end of the wire will be illuminated with a ſmall ſtar, or ſpeck of light, the ſame as is ſeen on the points of thoſe wires that collect the fluid from the cylinder, which is always a mark of their *receiving* the electric matter; at the ſame time, a pencil of diverging rays will be ſeen to iſſue from the oppoſite wire, on the other ſide of the glaſs, eſpecially if the hand, or other non-electric, be held within a few inches of it; this is alſo as evident a ſign, that that wire is *throwing off* the fluid.

When the glaſs is fully charged, (which may be eaſily known by the flaſhes of light, that will appear round the edges of it,) change the ſide, turning that wire from the conductor which, before, was towards it; that ſide of the glaſs which *wants* the fluid, will now be toward the conductor, and the ſide which is redundant, turned from it; the conſequence of which will be a much more violent *afflux* and *efflux* than before. It is really ſurpriſing to ſee with what eagerneſs and rapidity the point near the conductor receives the fluid, and the other carries it off, to any conducting ſubſtance that may be near it: But the operation, reſpecting the glaſs, is now juſt the contrary to what it was before—it was then *charging*, it is now *diſcharging*; and, if taken away from the conductor in proper time, it will be found to contain no charge at all; but, if continued longer, it will begin to charge again as before.

If this glaſs be held, in the ſame manner, to a *negative* conductor, the appearances will be juſt the reverſe,—the point toward the conductor will now throw out the diverging rays, and the other point be illuminated with the ſtar. If it be charged, in this manner, at one conductor, and the ſame point immediately applied to the other, the glaſs will diſcharge as when the contrary point was turned to the ſame conductor.

When the glaſs is fully charged, as often as that wire, which is on the ſide negatively electrified, be touched with a non-electric, the oppoſite wire will throw out a diverging flame; but, if the poſitive wire be touched, the other will have only an illuminated point.———In theſe experiments, the ends of the wires ſhould not be reduced to too ſharp a point, but left as they are cut off with a pair of nippers.

If a pane of glaſs be coated with emboſs'd gilt paper, inſtead of tinfoil, it will exhibit a very curious appearance in the charging of it; the ſparks of electric light will be ſeen on various parts of the paper, of different colours; and, if the exploſion be made by means of a chain, the glaſs will appear covered with fire on both ſides.

After a large phial has been diſcharged, and particularly when more than one is made uſe of, there will ſtill be a *reſiduum*, or ſmall quantity of the fluid remaining in it, which deſcends from the uncoated part of the glaſs; it may therefore be proper to apply the diſcharging rod to it a ſecond time, after the exploſion is made, before it be touched with the hand:

Much miſchief has frequently been done to an electrical apparatus, by a perſon's receiving a ſmall ſhock unexpectedly, which cauſes ſo ſudden a contraction of the muſcles, that the glaſſes, &c. are ſometimes ſtruck down.

There are inſtruments, very convenient for diſcharging of jars and phials, called *Electrometers*—they are made in different forms, but the beſt I know of, is that which fixes horizontally to the top of the phial: The metallic part of this inſtrument, which acts as a diſcharging rod, may be placed at any diſtance from the wire of the phial; by which means the exploſions will be made without farther application, always of an equal degree of force, and this greater or leſs, as may be required: It is particularly uſeful in electrifying a perſon for any complaint.

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ESSAY

On ELECTRICITY, &c.

PART II.

MEDICAL ELECTRICITY. *General Obſervations on the Electric Fluid, conſidered as a* MEDICINE, *with the Sentiments of different Writers on the Subject. Directions for its Application; and a Collection of various Caſes and Cures, indicating the Diſorders which ſeem moſt likely to yield to Electrical Treatment.*

SECT. I.

Of the Medical Effects of Electricity.

THE electric fluid ſeems to be replete with ſo many extraordinary and remarkable properties, that it is impoſſible to ſay, what great and beneficial diſcoveries may not hereafter ariſe from a practical enquiry into its nature and effects. If we conſider it in one intereſting point of view, it appears to be an object truly worthy of attention—I mean, the uſe that has been made of it in curing, or facilitating the cure, of a variety of diſorders in the animal ſyſtem. That electricity has effected ſuch cures, is, I think, beyond diſpute; it therefore only remains to enquire into the moſt eligible method of extending its utility.

THE diſcovery of *medical electricity*, like that of the *Leyden phial*, appears to have riſen rather from accident, than from any reaſoning on the ſubject *a priori.* Some remarkable cures having been, in a manner, caſually effected by electricity, more than twenty years ago, the novelty of ſo extraordinary a medicine, excited the curioſity of great numbers of people: The reſult of which was, what might naturally have been expected to ariſe from a too ſuperficial examination—ſome treated it as a mere chimera, and, either from caprice or deſign, endeavoured to explode its uſe; while others ſeemed to be in expectation of an abſolute *panacea*, and perhaps, with as little reaſon, beſtowed on it the moſt extravagant encomiums. Electricity, however, gained ground, being made uſe of by great numbers, and, by ſome means or other, was moſt frequently attended with ſucceſs.

IT was not to be expected that a ſcience which, even at this day, may be ſaid to appear only in its dawning rays, ſhould, in a few years, be inveſtigated with that degree of preciſion which is neceſſary either to eſtabliſh a *theory*, or to determine an exact mode of practice; but it is much to be regretted, that the practice has ſo long been confined chiefly to ſuch perſons, whoſe inveſtigations have been inſufficient to eſtabliſh a theory. Men of genius and literature have hitherto viewed the ſubject of electricity in a philoſophical light, much more than in a medical one. It is, indeed, with pleaſure that I now find there are ſome gentlemen of abilities and diſcernment, to whoſe province it more immediately belongs, that are diſpoſed to extend their enquiries into its efficacy as a medicine; becauſe it is from theſe only, that we are to expect any conſummate rules for its application, which muſt be founded on reaſon and experience.

A WRITER on the ſubject, a few years ſince, gave it as his opinion, that the electrical method of treating diſorders cannot be expected to arrive at any conſiderable degree of perfection, till adminiſtered and apply'd by gentlemen of the faculty——"Nay, "then, ſays he, all my hopes are at an end; for when "will it be adminiſtered and apply'd by them?—Not "till they have more regard to the intereſt of their "neighbours than their own; at leaſt, not till there "are no *apothecaries* in the land, or till phyſicians are "independent of them." I own I cannot entirely agree to this writer's concluſion; I had much rather believe there are many gentlemen of the faculty who, merely from a principle of benevolence, would heartily concur in the uſe of any medicine that might be found ſerviceable to mankind. It is certain that ſome of them have preſcribed electricity, in various caſes, and have preſcribed it with ſucceſs. Others, alſo, have lately very candidly told us, (what, indeed, we were tolerably well convinced of before) that *temperance* and *exerciſe* are the two moſt potent *drugs* in the whole *materia medica*—though ſome of us ſeem to think them the moſt naucious.

THE *apothecary* would certainly have but little reaſon to complain, though electricity ſhould come into general uſe, for, till intemperance and luxury become *unfaſhionable*, his drugs and compounds, to which mankind ſeem to have an inviolable attachment, will ſtill continue to be in demand—till *that time*, poor Human nature is doomed to groan under complaints, for the removal of which, *electricity* may be as vainly adminiſtered as the whole claſs of *exotics*.

IF any medical gentlemen ſhould be diſpoſed to treat the ſubject as chimerical, and unworthy of their ſanction, becauſe it has not yet been treated of *ſyſtematically*, or becauſe they cannot eaſily conceive, why the tranſmiſſion of a ſimple fluid through the diſordered body, ſhould be attended with ſo many ſalutary conſequences, I ſhall readily acknowledge myſelf unable to account for the operation of ſo ſingular a remedy—it may be ſufficient to claim their attention if the fact be confirmed by the evidence of ſenſe—and I can only appeal to the many caſes which may be brought, as *ſtubborn facts*, to prove the reality of the cures which have been effected merely by electrical treatment, and which cannot be denied without denying the teſtimony of a cloud of witneſſes.

It is certain, that a ſeaſonable application of electricity, has repeatedly been found extremely beneficial in a variety of caſes; in ſome, where drugs have failed, it has proved of the utmoſt ſervice; in others, it has appeared favourably to co-operate with other medicines, and has frequently ſuperſeded their uſe. Beſides the almoſt immediate removal of acute pains, and many dangerous complaints ariſing from obſtructions, flatulencies, &c. it has been found of ſingular utility in ſome chronical diſorders of long ſtanding, particularly of the nervous kind, of which, perhaps, there is ſcarcely a ſpecies, but what would yield, in a greater or leſs degree, to a judicious and perſevering uſe of electricity.

As the electric fluid is ſuppoſed to be the only one in nature that is capable of inſtantly pervading the fineſt tubes, and of actuating both the ſolids and fluids of the animal frame, with vibrations more or leſs forcible, as the nature of the caſe requires, its ſuperior efficacy, (when frequently repeated and varied) in the removal of thoſe diſorders which proceed from an obſtructed circulation, ſeems to be a conſequence naturally ariſing from the peculiar action of this fluid.

One thing, however, appears to be a little remarkable, in favour of electricity, as a medicine, that though it has often fallen into the hands of very unſkilful and injudicious perſons, who have apply'd it at random, in all caſes, without being capable of diſtinguiſhing either the nature of the diſorder, or the degree in which it ought to be adminiſtered, yet it has ſeldom or never been known to be attended with any bad effects; the patient has generally been relieved, and very frequently cured, but the ill conſequences have been even more rare than thoſe of inoculation.

If then, nine perſons out of ten, whoſe caſes were proper for electrical treatment, have been either cured or conſiderably benefited by it, which, I think, I may venture confidently to aſſert has been the caſe, whenever it has been duly apply'd, and continued; and if not one perſon in a hundred has received the leaſt injury from it, which may very reaſonably be preſumed, —I conceive this to be an argument pretty ſtrongly on the ſide of electricity, which can ſcarcely be urged in favour of any one remedy beſide.

Were it any argument againſt electricity to ſay, It has frequently been adminiſtered without effect,—the ſame might be urged againſt every medicine that has yet been made uſe of; or, if it were known to be really prejudicial in ſome caſes, it would make no more againſt the uſe of it in others, than againſt the uſe of *bark*, or *rhubarb*; and it would be as abſurd to expect certain relief from electricity, in any caſe, as to expect infallible benefit from the uſe of any drug whatever.

Many people, unacquainted with electricity, are too apt to treat it with neglect; others, who may have experienced it to be really beneficial in various caſes, have, perhaps, rated it too highly, and ſeem to expect from it more than we can reaſonably ſuppoſe it capable of effecting. As I apprehend, the chief, if not the ſole benefit ariſing from electricity, is effected by the *action* of that fluid, either in producing a tremulous, vibratory motion throughout the ſolids and fluids in general, and thereby accelerating the circulation of the latter; or, (particularly in the caſe of obſtructions) by actually pervading the finer channels of the fluids; by which means, thoſe paſſages may be opened, and the viſcous, ſtagnant fluid agitated to its natural ſubtilty. If any thing like this be the caſe, the phyſician will, doubtleſs, be able to point out what are thoſe diſorders, that are moſt likely to be removed by ſuch a treatment; and, at the ſame time, ſee that there are ſome complaints which cannot poſſibly be benefited by it.

As the beſt medicines in nature are liable to abuſe, ſo, without doubt, it is poſſible to render electricity very injurious to the human frame. But I conceive it to be impoſſible that the leaſt injury can ariſe from the *quality* of electricity; for, as this fluid is found to be as natural and common to all bodies as the *air*, it muſt be both *neceſſary* and *agreeable* to the human body. The injury therefore, that can poſſibly enſue, muſt ariſe from the *quantity* alone—from the too violent vibration given to the muſcles—the ſudden diſtenſion and contraction of the finer tubes and veſſels—and the *reſiſtance* made by the bones and ſinews (which are leſs perfect conductors) to the paſſage of the electric fluid, in turning it out of its direct courſe—this muſt occaſion what is generally called the *ſhock*, which may be rendered too violent to be ſuffered without conſiderable inconvenience, particularly to perſons of weak and tender nerves.

But the preſent more judicious method of applying electricity has rendered it evident that no caſe requires any of thoſe violent ſhocks, which were uſed to be given, without diſtinction of diſorder or patient, and which muſt have been attended with very ill conſequences,

quences, if the electric fluid, even when compreſſed in large quantities, was of a nature in any meaſure prejudicial.

WERE I really capable of advancing a *ſyſtem* of medical electricity, and of deducing a ſeries of poſitions and rules for its application, drawn from mature knowledge and obſervation of the ſubject,—yet I am ſenſible that an attempt of this kind, might be thought arrogantly aſſuming a character which cannot conſiſtently belong to my ſituation in life; but, as I can by no means lay claim to any ſuch qualifications, I am as ſenſible that what I have already written, muſt ſtand ſomewhat in need of an apology; and the beſt I can offer, is the motive which induced me to write it—a deſire of accelerating the progreſs of electricity, by exciting others, who have more leiſure and abilities, to make public the obſervations that may occur to them; which I conceive to be the moſt likely means of promoting a liberal enquiry into a ſcience, which appears to be worthy of the moſt aſſiduous attention.

IT is certain, that whatever concerns the health of mankind, is a ſubject of too ſerious a nature to be committed to any other preſcriptions than ſuch as are drawn from reaſon and experience; I am therefore extremely diffident in advancing any other directions for the uſe of electricity, than thoſe which have been repeatedly uſed with ſucceſs. I have, indeed, conceived a variety of modes, wherein it might be apply'd, in different caſes; but want of leiſure, and opportunity of reducing them to practice, renders them too precarious to be mentioned. The methods I ſhall venture to recommend are, either ſuch as I have uſed myſelf, or have known to have been uſed by others, and attended with very agreeable effects.

SECT. II.

Various Ways wherein ELECTRICITY *has been apply'd, and found ſerviceable in the Removal of different Complaints.*

THE moſt uſual method of applying electricity, is that of tranſmitting a quantity of the fluid through ſuch parts of the body, as are affected, and thereby producing a kind of vibratory motion in the muſcles, fibres, &c. This, as before obſerved, may be rendered more or leſs forcible, as the nature of the caſe may be ſuppoſed to require. It is attended with a very ſudden, but tranſient ſenſation, rather diſagreeable than painful, uſually termed the *electric ſhock.*[r]

THIS method often appears to be not only adviſeable, but expedient, when the diſorder is of ſuch a nature that it cannot be ſufficiently affected by the electric fluid, without its being condenſed in the coated phial: as in many caſes of obſtructions, fixed pains, and moſt of thoſe acute complaints which demand immediate relief. But even here, very *violent ſhocks* ſeem by no means neceſſary. By violent ſhocks I mean ſuch as may be rendered by means of the full charge of a jar containing two or three gallons: A jar of one gallon, about half or three parts charged, is generally ſufficient to anſwer every purpoſe of electrification; and, in moſt caſes, leſs than this will be found ſufficiently efficacious, when the patient has opportunity of having the operation frequently repeated.

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[r] I could wiſh that thoſe who treat of medical electricity, would endeavour to adopt ſome other more ſuitable term, for the paſſage of the electric fluid, than that of *ſhocking.* It is apt to convey a terrifying idea to a ſick perſon. There is certainly nothing very *ſhocking* in the caſe; and the word can never be uſed with propriety, but when very large jars are made uſe of, and the exploſions rendered exceeding forcible.

But there are many diſorders which are found to yield to the more mild and gentle method, generally called *drawing of ſparks*; which, to have the deſired effect, ſhould, in moſt caſes, be continued for ten minutes, or a quarter of an hour; and repeated two or three times a day.

Other complaints, particularly thoſe of the nervous kind, are frequently relieved by ſimply electrifying—I mean, a perſon's ſitting in a chair, ſupported by a board with glaſs legs, in contact with the prime conductor of the machine, for about half an hour, or longer if convenient, once or twice a day: By this means, while the operation is performing, the perſon becomes replete with the electric fluid, which circulates in every part, and flies off from the ſurface of his body. The particles of this fluid being ſtrongly repulſive of each other, and, at the ſame time attractive of every particle of heterogeneous matter, particularly the animal fluids, it muſt therefore, in the above circumſtances, be vigorouſly impelled and circulated through every tube.

It has been ſaid, that this method of treatment generally increaſes the number of pulſations conſiderably; by which means the circulation of the blood, &c. is ſuppoſed to be accelerated; but I cannot ſay, from the few obſervations I have made on it, that this is always the caſe; I have ſometimes perceived no ſenſible difference; at other times there ſeemed to be an increaſe of about ſix or eight pulſations in a minute: The patient, however, generally finds himſelf more warm, animated, and chearful, after the operation.—It might, perhaps, be worth while to make a few accurate obſervations on this ſubject, in order to determine the different effects (if any) of a *repletion* of the electric fluid in the animal body, and a *privation* of its natural quantity;—which might be effected by placing a perſon on a board *negatively* electrified.

It is pretty clear that, either the *nature* or *action* of the electric fluid, is highly exhilerating to the human frame. Let a perſon inclinable to be chilly, languid, inactive, oppreſſed, or ſubject to a nervous *lowneſs of ſpirits*,—if it be merely for the ſake of a *diverſion of thought*, let him think of amuſing himſelf with a few electrical experiments—let him rub his machine, and ſet it in proper order—then, placing himſelf on the *electrified board*, he will be able (by the help of another perſon to turn the wheel) to perform moſt of the experiments of electrical attraction and repulſion, the ſame as though he did them ſtanding on the floor, by the prime conductor; in fact, he will be a part of the conductor himſelf, and partake with it of an equal denſity of the fluid, though totally inſenſible of its action. He will attract any light ſubſtances that approach him, from a non-electrified body. If he holds in his hand ſome downy feathers, he will find their fibres immediately grow turgid, and become uncommonly expanſive. He may charge a phial, by holding the external coating in his hand, and applying the wire to any unelectrified body. He may ſet fire to ſpirits, and other inflammable ſubſtances;—in ſhort, the variety of experiments that may be performed in this manner, is as engaging as the diverſity of agreeble ideas they muſt excite.

Would a perſon, in the above circumſtances, ſuffer himſelf to be perſuaded (and ſuch perſons have generally need of perſwaſion) into the uſe of this placid kind of exerciſe, for an hour or two every day, varying the mode ſo as to prevent a tireſome repetition; I ſhould venture to aſſert, that in a few weeks he would find in himſelf a conſiderable alteration for the better.

I will not ſay that a perſon is likely to receive more benefit from this ſort of electricity the firſt, the ſecond, or the third time of his engaging in it, than he might expect from only once or twice uſing the cold bath, or taking an airing on horſeback; but I think he muſt be pretty far advanced in *hypochondriaciſm*, to whom the united force of theſe three ſpecifics, does not afford effectual relief in leſs than three months.

A most excellent kind of exerciſe for ſuch perſons, if they are not too lazy, or too obſtinate to uſe it, is *rubbing an electric glaſs tube.* This tube is generally about three feet in length: It may be rubbed with a piece of flannel, or oiled ſilk. Holding the tube by the end, in one hand, and the flannel in the other, let it be rubbed briſkly up and down, till the tube appears to be excited. The knuckles being then apply'd, with a quick motion, from the lower end of the tube to the top, the electric matter will ruſh from it with a crackling noiſe, and, in the dark, will have the appearance of ſtreams of fire. Let a perſon exerciſe himſelf ſmartly in this manner for a quarter of an hour, and I'm perſuaded, if he is not of a habit uncommonly phlegmatic, he will find himſelf in an agreeable perſpiration. He will not only receive the benefit of the *exerciſe*, which actuates every muſcle, but alſo that of a *double current* of the electric fluid; firſt, from the floor, through his body and one of his arms, to the tube, where it will be accumulated; then, by ſucceſſively applying the knuckle of his other hand along the tube, he will again receive the fluid through him, and convey it back to the floor. In bad weather, when a perſon is obliged to confine himſelf to his chamber, this flux of etherial matter may, perhaps, not improperly be conſidered as a deſireable *ſuccedaneum* for exerciſe in freſh air.

IN electrifying for any particular complaint, when the coated phial is made uſe, I cannot conceive it to be of much importance what courſe the fluid is directed to take—whether it be *to* or *from* the part affected; as, ſuppoſing the caſe to be rheumatic, and the ſeat of the diſorder to be chiefly in one arm and ſhoulder, it ſeems not very material, whether the current of electric matter be directed ſo as to enter the ſhoulder, and come out at the hand, or the contrary. But, if this ſhould be thought of any conſequence, it may be proper to remind the reader that, after the phial is charged in the common manner, at the prime conductor, when the diſcharge is made, the fluid paſſes from the *inſide*, through whatever conductors form the circuit, to the *outſide* coating: Conſequently, in the above caſe, if the perſon holds in his hand a chain in contact with the outſide of the phial, and another chain be fixed on the ſhoulder; as ſoon as this chain is brought to touch the prime conductor, the diſcharge will be made, and the fluid paſs in at the ſhoulder and out at the hand.

IN drawing the electric ſpark, the perſon who approaches the conductor receives from it the fluid, into whatever part of his body is apply'd to it: But if he ſits upon the electrified ſtool, the fluid is taken from him when the ſparks are drawn. This may very conveniently be done another way, without the ſtool, by means of an *inſulated diſcharging rod.*[s] The chain of this rod being faſtened to the *negative* conductor, (while the prime conductor leads the fluid to the earth by means of a chain) a perſon may then draw ſparks from himſelf, by holding the diſcharging rod by the middle of the glaſs tube, and applying the end of it to any part of his body.

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[s] This diſcharging rod conſiſts of a thick braſs wire, run through a tube of glaſs—having a chain at one end, and a braſs ball at the other.

WHEN the ſtool is made uſe of, care ſhould be taken that no part of the clothing touch the floor, or other non-electric, ſo as to convey off the fluid.

As the electric ſparks cannot eaſily be drawn through a quantity of thick clothing, particularly woollen, it will be moſt convenient to take them from the bare ſkin; If they are found to be too pungent, a piece of tinfoil, or thin ſheet lead, may be placed over the part, which will render them more mild, and the operation may be continued longer.

IN moſt caſes it may be proper to begin with drawing of ſparks from the part affected, and then proceeding to moderate diſcharges of the phial. Theſe diſcharges may be varied in ſtrength, and given in different directions; changing the place of the conducting chains, ſometimes farther off, then nearer to the ſeat of the complaint, by which means, part of the fluid muſt neceſſarily paſs through it; in general, however, the nearer the chains are kept to the affected part, the better.

IT is obſervable that, though thoſe parts of the body which are diſordered, by obſtructions, &c. may not be more tender or ſenſible than the reſt, yet the patient commonly feels the paſſage of the fluid through ſuch places, much more ſenſibly than in any other part, if the chain is properly placed; excepting only the extremities, where the chains touch the ſkin.

WHEN a perſon has once or twice made uſe of the electrical machine, he will very readily be able to judge what number of diſcharges, and what degree of force are requiſite to be uſed. Few caſes, perhaps, require more than ten or a dozen moderate ſhocks, at one time of electrifying: But, in general, the more frequently theſe are repeated, ſo as not to render the operation diſguſtful, the ſooner may permanent relief be expected.

It is by no means to be ſuppoſed, that the effect of electricity will always manifeſt itſelf immediately after the firſt operation. Though there are ſome complaints which will ſometimes be immediately removed, there are more that require a frequent repetition, before much ſenſible benefit ariſes. Others have been found not to yield in any degree to the power of electricity, for ſome weeks, till, by perſevering in the uſe of it, and by varying the method, they have at length been entirely reduced.

If, therefore, we find electricity to be attended with little or no effect after the firſt or ſecond time, it ſeems to be no indication of an unſucceſsful repetition; and I am inclined to think, that where it has been apply'd without ſucceſs, (when the caſe has been a proper ſubject for it) its failure has generally been owing to the irreſolution, and diſlike of the patient, or to an improper method of application, rather than to the inefficacy of the remedy.

It would, perhaps, be to very little purpoſe, to attempt laying down particular directions for the application of electricity, even in the moſt common caſes: The ſituation of patients, who are proper ſubjects for electrical treatment, is generally ſo precarious as to admit of but few rules but what are diſcretionary, and variable according to different circumſtances. Whoever has formed a general idea of the mode of operation, his judgement may ſoon lead him to diſtinguiſh the moſt judicious method of applying it in particular caſes. I ſhall, however, mention a few, which may be of ſervice to thoſe who are ſtrangers to the ſubject, and then proceed to ſome of the caſes in which electricity has been of ſingular ſervice.

In moſt diſorders ariſing from obſtructions, it is generally neceſſary to direct the paſſage of the fluid, by means of the coated phial, immediately through the parts affected; and ſometimes, if the complaint be more general, all over the body, by placing the chains in various directions: They may be held in the hands, or put under the feet; they may be laid upon any of the limbs, the head, or any part of the body; the paſſage of the fluid will always be from one chain to the other, the ſhorteſt way it can take, and the vibrations will be made in every part that lies in the courſe of its direction.

THE momentary ſenſation of pain at each diſcharge of the phial, which is chiefly felt at the two places where the ends of the chains are fixed, may be rendered much leſs acute, by means of a thin piece of lead, of a circular or oval form, about an inch and half broad, faſtened to the end of each chain—a piece of paper, or thin leather, may be paſted over the lead —this being preſſed pretty cloſe to the fleſh, by holding it down with a ſilk handkerchief, or piece of flannel, takes off ſo much of the pungency of the diſcharge, that it is ſometimes far from being diſagreeable.

IF the pain or ſeat of the diſorder, be in the breaſt, ſtomach, or arms, the moſt ready way of conveying the fluid to it, is to let the patient hold in his hand the end of the chain that communicates with the outſide of the phial, and, in the other hand, a chain fixed to an electrometer; this being placed about a quarter of an inch, more or leſs, from the prime conductor, will receive the ſparks from it, when the phial is charged; and the fluid will be conveyed through the affected part.

WHEN it is required to give an univerſal vibration throughout the body, the perſon may ſtand upon a pewter or tin plate, and let the end of a chain drop down on it, from the outſide of the phial. When the phial is charged, he may touch the conductor with a ſmall metal rod, held in either hand, or elſe hold in his hand the chain of the electrometer. If he applies the rod to the conductor, let him hold it in ſuch a direction, that the back of the hand may be *upward*, and touch with the rod the *lower*, or under part of the conductor, by which means he can never ſtrike it, ſo as to throw it down.

Agues, Epileptic, or Hyſteric-Fits, and other complaints in which the whole body is affected generally require theſe univerſal vibrations; and a larger quantity of the fluid is requiſite to be compreſſed in the phial, than when the ſhock is deſigned to be only partial. A quantity moderately large, is generally attended with a leſs acute ſenſation than when it is ſmaller.

Deafness has been frequently cured by tranſmitting a ſmall quantity of the electric fluid through the head; a chain being placed to each ear; one of the chains fixed to the outſide of the phial, the other to the electrometer—the phial being but lowly charged.

Some Obſtructions are eaſily removed by the perſon's ſtanding on the ends of two chains, hanging down on the floor, one of them from the outward coating of the phial, the other from the electrometer—the charges being moderate, and the operation repeated twice or three times in twenty-four hours.

Swellings in the face, neck, or other places, are oftentimes very ſoon reduced by a few moderate diſcharges of the phial through the part; but theſe will frequently be found to yield to the drawing of ſtrong ſparks from the place, without uſing the phial.

A Sore-Throat, when taken on the approach of the firſt ſymptoms of the diſorder, is generally effectually cured by a perſon's ſtanding on the electrified board, and drawing ſtrong ſparks from different parts of the throat, for about ten minutes.

Coagulated-Blood is very ſoon diſperſed by the ſame method.

The extravaſation of blood in the eyes, commonly call'd *blood-ſhotten*, has been remov'd very ſpeedily by drawing of ſmall ſparks from them,—the eye-lids being cloſed. There is a ſmall inſtrument, conſiſting of a glaſs tube, and adjuſting wires, made on purpoſe for this uſe: Likewiſe, another for conveying the electric matter to the teeth, by which the moſt violent *tooth-achs* have ſometimes been inſtantly cured.

SECT. III.

A Collection of various Caſes, and Cures effected by Electrical Treatment.

It has been chiefly from obſerving the operations and phænomena of nature, that men have attained to ſuch a knowledge of her laws, as to be able to pronounce many of them invariable; and from hence they are conſtantly led to expect ſimilar effects from a ſameneſs of cauſe.

Nature, however, is found to be ſubject to ſo great a variety of irregularities and diſorders, that philoſophers, of the moſt penetrating genius, have never yet been able to trace them to their original ſpring. The utmoſt they have been able to do, has been to link together a chain of conſequences,—from theſe *effects* (by purſuing an analytic method of reaſoning) to form ſome probable conjectures concerning the *cauſe*;—and to evade ſome of thoſe calamities which have been termed the evils of *nature*, by calling in the aſſiſtance of *art*.—And, indeed, to do thus much, ſeems to be an arduous taſk for feeble humanity.

So many are the diſorders of the *animal* ſyſtem, that phyſicians have found it neceſſary to arrange them into diſtinct claſſes, and to diſtinguiſh them by certain appellations and diagnoſtics. To each of them they have alſo appropriated the uſe of certain drugs and compounds, which experience has led them to conclude to be more or leſs certain *remedies* for thoſe diſorders; and, though they ſeem not yet to be entirely agreed in opinion, which are to be preferred, in ſome particular circumſtances, yet moſt of them are ready to allow, that practical *experience* is, in general, a more ſafe guide than theoretical *ſpeculation.*

Hence they have been induſtrious to record ſuch particular Cases as they have ſuppoſed to be worthy of obſervation, together with the method of treatment, effects of the medicine, &c.——*Caſes* in Physic, like *Precedents* in the Law, ſerve to determine the practice with ſomewhat more certainty.

When the effects of *electricity* in the cure of ſome diſeaſes, were firſt diſcovered, it was natural that the diſcoverers ſhould particularly remark the caſes, and publiſh to the world this extraordinary remedy. Whether they did this from motives purely benevolent, or with more lucrative intentions, is hard to ſay; but, whatever were their views, the remarks have certainly been of ſome benefit to mankind. By repeating, or improving the methods they made uſe of, many people have got rid of diſorders which appeared to be beyond the effects of medicine.

And, as we are to ſuppoſe that electricity has frequently been made uſe of with little or no ſucceſs, perhaps, by this time it would have been of more extenſive ſervice, if thoſe who were much engaged in it had, like the late worthy and unprejudiced Dr. Franklin, candidly recited the particular caſes wherein they might have found it to fail: Phyſicians would then, by comparing the nature of the remedy with that of the diſorder, have been better able to determine how and when to adminiſter it, and in what complaints it would be moſt likely to ſucceed.

For a few years paſt, ſince I have made any particular enquiries into the ſubject, I have from time to time collected, from different perſons and writers, as many caſes as I could; and have now by me ſome hundreds of them. I intended, by comparing the various accounts, to have digeſted ſome of them into ſeparate claſſes, in order to diſtinguiſh, in ſome meaſure, the different ſpecies of diſorders, which appear more or leſs likely to be benefited by electrical treatment: To claſs thoſe together that appeared, upon the whole, to be leaſt liable to exceptions, and in which electricity had been attended with the greateſt and moſt conſtant ſucceſs,—Others, in which it had proved more dubious, and leſs efficacious,—Others again, wherein it had failed, or been attended with but little benefit: But finding myſelf unequal to the taſk, I muſt leave it to thoſe who are better able to perform it, and ſhall only arrange ſome of the caſes in alphabetical order, and inſert them generally verbatim as I find them drawn up.

St. Anthony's Fire.

Case 1. ‘ Having obſerved (ſays Mr. Lovett) ‘ the great efficacy of the electrical æther, in ſoon relieving moſt kinds of inflammations, I was inclined ‘ to think the ſame ſalutary effects would appear when ‘ apply'd to the *St. Anthony's Fire*; but, when a caſe ‘ of that ſort offered, the inflammation was ſo great, ‘ that, at firſt ſight, I almoſt deſpaired of ſucceſs.

‘ About the middle of the day I made the firſt trial, ‘ and before night the ſwelling was much abated, and ‘ in a few days quite cured.

‘ THE operation was ſimply drawing of ſparks, with ‘ a finger, or an iron ſtyle, while the perſon was electrified on the reſin.’[t]

[LOVETT’s *Electricity rendered uſeful.*]

CASE 2. ‘ *April* 2, 1763, my wife walked too ‘ long, as appeared by the conſequence, in the evening, in the garden. Next morning an Eryſipelas ‘ appeared in her face. Her chin was ſwelled, inflamed, and full of ſmall puſtules. By night the ſwelling had reached her right cheek, and was proceeding to her neck and forehead. Her right eye ſeemed ‘ to be cloſing up, and her whole face was very ſore ‘ and painful; ſhe alſo found a ſickneſs at her ſtomach. She aſked, if I did not think drawing ſparks ‘ from her face would be of ſervice to her. I drew ‘ ſparks from it for about ten minutes. The inflammation inſtantly ſtopped, the ſickneſs went off from ‘ her ſtomach, and the ſoreneſs was much abated. ‘ She could bear now to preſs and rub it. Next morning all her face and head was a little ſwelled; but ‘ drawing ſparks about five minutes at a time, night ‘ and morning for five days, perfectly cured her. She ‘ has never had the leaſt appearance of an Eryſipelas ‘ ſince.’ [SYMES’s *Treatiſe on Fire.*]

AGUES.

CASE I. ‘ ANNE HEATHCOTE, daughter of Mr. ‘ HEATHCOTE, Brazier, near *Moorfields*, was ſeized, ‘ in *May* laſt, with what is commonly called an *Ague* ‘ *in the Head*, having a violent pain in her head, face ‘ and teeth. After trying abundance of remedies, to ‘ no purpoſe, ſhe was, in *Auguſt*, electrified through

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[t] Before the more convenient method of ſitting in a chair, placed on a glaſs-legg’d board, was uſed, the patient generally ſtood on a cake of roſin.———The beſt thing for drawing the ſparks, is a diſcharging-rod, with a braſs knob.

‘ the head. Immediately the pain fixed in her teeth. ‘ She was electrified four times more, and has felt ‘ nothing of it ſince.’ [WESLEY's *Deſideratum.*]

CASE 2. ‘ In *January*, 1761, I was apply'd to, for ‘ two children (Sons of Mr. CHANCELLOR, Taylor, of ‘ *Briſtol*, the eldeſt nine years old, the other five) to ‘ electrify them on account of a *Tertian Ague*, which ‘ had ſtubbornly reſiſted all applications. I ordered ‘ the children to be brought to me, juſt as the ague ‘ was coming upon them; Experience having taught ‘ me that this is the only time to give the ſhock with ‘ efficacy. They were electrified only twice, and were ‘ perfectly cured, by paſſing thro' them four ſlight ‘ ſhocks, two through the ſtomach, and two through ‘ the ſides.

‘ IN *March* following one of the children fell into ‘ the water, and his ague returned. He was brought ‘ to me again, but then the electrical ſhock had not ‘ the leaſt effect.’ [SYMES.]

CASE 3. ‘ *March* 27, 1764, walking a little way ‘ from my houſe, and looking on a poor man digging ‘ ſtones, he ſuddenly dropt his tool, and cry'd out, I ‘ can't work, I muſt go home. His ſoliloquy natu- ‘ rally led me to enquire, why? Sir, reply'd he, I ‘ have had a *third day's ague* for theſe ſix weeks, and ‘ now I feel it coming upon me. I took him imme- ‘ diately to my machine, and paſſed four ſhocks ‘ through him croſs-ways. Two from the right hand ‘ to the left foot, and two from the left hand to the ‘ right foot. I ſaw no more of him till *April* follow- ‘ ing; when he told me he never had the ague but ‘ once after, and that only for three minutes: He ‘ was then well and hearty. His name is WILLIAM ‘ CARTER, aged ſixty.’ [IDEM.]

BLINDNESS, Decay, or Loſs of SIGHT.

CASE I. Extract of a Letter from Mr. FLOYER, Surgeon, at *Dorcheſter*, to Dr. BENT, at *Exeter*. *May* 23, 1751.

'I HAVE lately had two or three opportunities of 'trying the effects of electricity on paralytic perſons, 'with ſucceſs: What moſt tends to prove its good 'effects on the human body, is the following caſe:

'A BOY about ſeven years of age, was taken blind 'ſuddenly in both his eyes, without any previous 'fever, pain, or diſorder. Three or four days after 'he had loſt his ſight, he was brought to me. Upon 'inſpecting his eyes, I found the pupil of each ſo 'entirely dilated, that I could not diſcover of what 'colour the iris was, not the leaſt verge of it to be 'ſeen, but the cornea, tranſparent, appeared one continued black ſpot. I told his parents I believed he 'would never be able to ſee again, for there was ſeldom or never a cure for ſuch diſorders of the eyes, 'taking the caſe to be a perfect Gutta ſerena in both 'eyes. I determined, however, to try the effect of 'the electrical ſhock, as I had met with ſucceſs in 'ſome caſes before. Accordingly I faſtened a wire 'from the outer coating of the phial to his leg, and 'another round his head, which being brought to 'the conductor produced a ſtrong exploſion. I repeated the ſhock three times more. He was put to 'bed, and continued there till the next morning in 'profuſe ſweat. He agreeably alarmed his father in 'the morning, by ſaying he could ſee the window. 'When he was brought to me, I perceived a ſmall 'circular rim, of a light grey colour, round the outſide of the iris, and obſerved that he knew when I 'put my hand between his eyes and the light, which 'he did not before, tho' in the ſunſhine. This gave 'me encouragement to repeat what was done the day

‘ before. The next day almoſt half the iris could be ‘ ſeen, with ſome ſmall degree of contraction and dilatation. The third day he could diſcover and diſtinguiſh objects. The fourth he could diſtinguiſh ‘ colours, with briſk contractions of the iris. The ‘ fifth day, after repeating the operation, I obſerved ‘ the iris to contract and dilate as well as ever; and, ‘ upon a ſtrict examination, found his ſight to be perfectly reſtored, and the eyes, in every reſpect, as ‘ well as if they had never been diſordered.’

IN a ſubſequent letter, dated the *December* following, Mr. FLOYER informs Dr. BENT of the Boy's continuing well. That he had his caſe atteſted by thoſe who ſaw him electrified; and that many, who had heard of this extraordinary cure, came to ſee, and examine him. He alſo mentions a circumſtance that he had forgot, in his former letter—the application of a bliſter plaiſter to the nape of the boy's neck, the day before he was electrified. This he had done the firſt thing, but never thought of it afterwards, till it was almoſt dry'd up. He doubts whether this had any ſhare in effecting the cure, but thought proper not to omit the mentioning of every circumſtance.

HE likewiſe informs Dr. BENT of ſome other cures which he had performed by means of the electric ſhock, particularly two girls, whom he had cured of obſtructions, one of whom had taken medicines for twelve months without effect.

CASE 2. Mr. WESLEY, in his *Deſideratum*, aſſerts the following accounts, tranſmitted to him from a gentleman of *Newcaſtle-upon-Tyne*.

‘ LAST week a poor man in *Sandgate*, that had been ‘ blind twenty-four years, was led to the machine. I ‘ ſet him upon the electrical board, and drew ſparks ‘ for about twenty minutes from the pupil of his eyes.

‘ After he had reſted himſelf a little, and was able to ‘ look up, he told us he could ſee *Sidgate*, which he ‘ had not ſeen for many years before. He could alſo ‘ diſtinguiſh objects in the room, and was able to walk ‘ home without a guide. He came a ſecond time, ‘ and was ſo much better, that I imagine he did not ‘ think it neceſſary to come any more.’

CASE 3. ‘ He adds,’ About the time I wrote laſt, ‘ a young woman was cured of a fourteen years blindneſs. She was able, before ſhe went home, to diſtinguiſh one letter from another.’

CASE 4. ‘ From the ſame perſon, a few days afterwards, I received the following lines.

‘ THE cure of the blind man of *Newcaſtle*, has ſpread ‘ through all the country; in conſequence of which, ‘ I am, much againſt my will, become an occuliſt. ‘ I have ſeveral in hand, among the reſt a girl, about ‘ ſeventeen, has been with me three weeks. Her caſe ‘ is owing to a film, or ſkin, grown over her eyes. ‘ It came by the Small-Pox, about twelve years ſince. ‘ Her friends have had all advice, and uſed all the ‘ means in their power to no purpoſe; except that ſhe ‘ has loſt her left eye irrecoverably by one of the perſons they apply’d to.

‘ WHEN ſhe came to me the iris of the right eye was ‘ very nearly covered with a thick ſkin, ſo that ſhe ‘ could do little more than diſtinguiſh day from night. ‘ The method I have taken is drawing ſparks from her ‘ eye, and ſometimes giving ſhocks, from her head, ‘ or neck, down her arm, to carry off the frequent ‘ complaints of pain and dizzineſs in her head, which ‘ never fails of ſucceeding in about ten minutes. We ‘ have electrified her about half an hour, twice every ‘ day. The ſkin waſtes gradually, and daily grows ‘ thinner; ſo that now the colour of her eye appears 'through it. The other day, as I had her in hand, 'ſhe ſaw the buttons of my ſhirt ſleeve; but her eye 'is yet very weak.'

CASE 5. 'In *January* 1762, a poor woman, aged 'about thirty, came to my door begging. She was 'almoſt blind. On enquiry I found her blindneſs was 'cauſed by a blow with a potatoe, about two years 'and a half before: It was flung with great force, 'and ſtruck her in the right eye, with which ſhe had 'never ſeen, owing to an injury ſhe had received in 'her infancy. But the left eye, till that accident, 'was always ſtrong. An inflammation immediately 'enſued; and, when ſhe came to me, the right eye 'was much ſwelled, and protuberated out of the 'ſocket. The anguiſh was very great, and ſo affected 'the left eye, that ſhe had no more ſight left than 'juſt ſufficient to go about to beg.

'I TOOK her to my machine, and drew ſparks from 'both her eyes. She ſeemed better, before ſhe quitted 'the room; but by next morning was conſiderably 'ſo. After drawing ſparks from her eyes, about ten 'minutes at a time, for four mornings, ſhe ſo far recovered 'her ſight, that ſhe could ſee to ſew a whole 'day together. In about five weeks I diſmiſſed her 'as perfectly cured.' [SYMES.]

CASE 6. 'IN the ſpring of the year 1763, a lady 'was perſuaded to try the effect of electricity for her 'ſight. It had been gradually decaying for ſome 'time. A film could be perceived gathering over the 'iris, and making its way to cover the pupil. One 'eye, in particular, was ſo darkened that ſhe could 'not ſee with it either to read or thread a needle.

'I DREW ſparks from her eyes about the ſpace of 'three or four minutes every morning, for a fortnight. 'She found her eyes ſurpriſingly mended;

‘ and thoſe who ſtood by could, as it were, ſee the ‘ curtain draw back from the pupil and iris. She at‘ tended afterwards, at times, for ſix weeks longer, ‘ and when ſhe left me, was able to thread the fineſt ‘ needle, and to read the ſmalleſt print.’ [IDEM.]

BRONCHOCELE.

CASE 1. ‘ SUSANNA REA, of *Worceſter*, was troubled ‘ with a *Bronchocele* (the moſt obſtinate of all ſwellings) ‘ for ten or eleven years. It began on the right ſide ‘ of her wind-pipe, and gradually increaſed over it, ‘ till her neck was more than eighteen inches about. ‘ This ſwelling was electrified; and ſparks drawn from ‘ it once a day for three months. The ſwelling is now ‘ conſiderably abated; the ſmalleſt part of the neck is ‘ not quite thirteen inches, the largeſt about fifteen ‘ and an half. What ſwelling remains, is at one par‘ ticular part only, and has now the appearance of a ‘ *wen*, but is much more ſoft, and appears to waſte ‘ much faſter than at firſt.’ [LOVETT.]

CASE 2. ‘ Another perſon, troubled with the ſame ‘ diſorder, but not of ſo long continuance, has lately ‘ began with the ſame operations; and the ſwelling a‘ bates much faſter than the former.’ [IDEM.]

BRUISES.

CASE 1. ‘ WILLIAM JONES, a plaſterer, in *King-* ‘ *ſtreet*, *Seven-Dials*, fell from a ſcaffold. He was ‘ grievouſly bruiſed, and lay in violent pain, utterly ‘ helpleſs, for two days, when he was brought by two ‘ men, to be electrified. This well-timed application ‘ of electricity was ſo effectual, that the man walked ‘ home alone, and the next week went to his work. [WESLEY.]

CASE 2. ‘ MARY OSGATHORP had her foot bruiſed ‘ by a ſtone falling on it, which occaſioned a running 'ſore. It continued, (tho' frequently healed for a 'time) upwards of eight years; but was entirely cured 'a month ago, by electrifying, and has never broke 'out ſince.' [IDEM.]

BURNS AND SCALDS.

WE have ſeveral inſtances of the good effects of electricity when apply'd immediately after the accident.—The general method is to draw ſparks from the place, which generally prevents bliſters, and appeaſes the pain.

COLDNESS IN THE FEET

is likewiſe effectually cured by a few moderate ſhocks, daily repeated for ſome time. The perſon may ſtand on a plate of tin, and a chain be faſtened to any part of the leg.

CONTRACTIONS.

'ELECTRICITY has certainly removed ſo many com-'plaints of this kind, that it deſerves to be try'd 'wherever they occur.'

CASE 1. 'One who had loſt the uſe of his limbs, 'from cold, for ſeveral years, was, at length, quite 'reſtored by the uſe of electricity.'

CASE 2. 'Another, whoſe knee-joint had been 'above five years contracted from a rheumatiſm, was 'able to ſtraighten it after twice electrifying.'

[LOVETT.]

CASE 3. 'Dr. HART, in a letter to Dr. WATSON, 'dated *Salop*, *March* 20th. 1756, mentions a cure per-'formed by electricity, upon a woman whoſe hand 'and wriſt had been, for ſome time, rendered uſeleſs 'by a violent contraction of the muſcles. She was 'not ſenſible of the firſt ſhock that was given her; 'but, as they were repeated, the ſenſation increaſed, 'till ſhe was perfectly well. She was alſo cured a ſe-'cond time, after a relapſe occaſioned by a cold.'

[PHIL. TRANS.—PRIESTLEY.]

CASE 4. ‘But perhaps the moſt remarkable caſe that has yet occurred of the uſe of electricity in curing a diſorder of this kind, and indeed of any that is incident to the human body, was of that dreadful diſorder, an univerſal *tetanus*. It is related by Dr. WATSON, in the Philoſophical Tranſactions; and the account was read at the Royal Society, the 10th of *Feb.* 1763. The patient was a girl about ſeven years of age, who was firſt ſeized with a diſorder occaſioned by the Worms, and at length by an univerſal rigidity of her muſcles; ſo that her whole body felt more like that of a dead animal, than a living one. She had continued in this diſmal condition above a month, and about the middle of *Nov.* 1762, after all the uſual medicines had failed, Dr. WATSON began to electrify her; and continued to do it, by intervals, till the end of *January* following; when every muſcle of her body was perfectly flexible, and ſubſervient to her will, ſo that ſhe could not only ſtand upright, but could walk, and even run like other children of her age.’ [IBID.]

CASE 5. ‘M— D—, had been afflicted with the moſt violent *Cramp* in her legs I ever heard of; which diſorder ſeized her before ſhe was twenty years of age, and continued (at intervals) till the operation was performed, when ſhe was upwards of ſeventy. This was moſt violent always when in bed, at which time ſhe was forced to tumble out on the floor, and this, ſometimes, twice or thrice the ſame night: The violent convulſed muſcular parts forming themſelves into diſtorted ridges, attended with exquiſite pain, burſting the ſmall blood-veſſels, which afterwards appeared of a livid hue, for a conſiderable time. This was entirely cured in a few days. The operation was ſhocks only, and performed once a day, thus: Having taken off her ſhoes, ſhe put one

‘ foot on the end of the chain which came from the ‘ outer coating of the charged phial; then putting ‘ one end of a thick wire to the other foot, by bringing the other end to the conductor, the electric matter was conveyed through both legs, at the ſame ‘ time.’ [LOVETT.]

CASE 6. ‘ Another perſon, who had rigid knots ‘ in the thigh, like thoſe appearing in violent Cramps, ‘ though much more ſoft, and leſs painful; they were ‘ entirely diſperſed, in a minute or two, by ſimply ‘ drawing ſparks from the part affected.’ [IDEM.]

MR. WESLEY ſays he never knew electricity to fail, when apply’d to that painful contraction called the Cramp. [DESIDER.]

DEAFNESS.

‘ WHEN this ariſes from harden’d wax, or following ‘ a fever, it is often cured by only drawing off ſparks.’

CASE 1. ‘ At *Stockholm*, a gentleman of diſtinction, who had been almoſt *deaf*, a conſiderable time, ‘ with a ſinging in his ears, was perfectly cured in ‘ three or four minutes.’

CASE 2. ‘ A Man fifty-ſeven years old, who had ‘ been deaf for thirty-two years, was ſo far relieved in ‘ a few days, as to hear tolerably well.’

CASE 3. ‘ SAMUEL JONES, Gardener, at *Lambeth-Marſh*, leap’d into the *Thames*, to ſave a man from ‘ drowning. Hereby he became ſo deaf in both ears, ‘ that he could not hear any ſound at all, were it ever ‘ ſo loud. After being once electrified, he could hear ‘ the noiſe of a coach, at ſome diſtance. After the ‘ third time, he could hear the ſound of the electrical ‘ machine. He came no more, ſo it is ſuppoſed he ‘ is well.’ [DESIDER.]

CASE 4. MR. WILSON, in his Treatiſe on Electricity, gives us an account of a remarkable cure which he performed, in the year 1748, on Mrs. M. SMARGINS. She had been deaf (from a cold at firſt) for ſeventeen years, and could hear nothing that was ſaid to her, unleſs ſpoken very loud in her ear. Mr. WILSON tranſmitted a ſmall charge through her head, juſt above the ears. She was immediately ſenſible of a degree of warmth in her head, from one ear to the other. The diſcharges were repeated four times, each increaſing a little in ſtrength. The warmth increaſed at each ſhock, particularly in that ear with which ſhe heard the leaſt, and continued all day, with a kind of twitchings in the ear. The next morning the operation was repeated. The twitchings became more violent, and the warmth greater round the ears. Theſe effects continued all the day, and ſhe heard conſiderably better. On continuing this method for a few days, ſhe was perfectly reſtored to her hearing, which continued without a relapſe.

AT the time when ſhe was firſt electrified, ſhe had a cold, and her eyes were much inflamed. The inflammation decreaſed after the firſt operation, and was entirely removed immediately after the ſecond.

WE have many inſtances wherein electricity has been ſucceſsfully apply'd in caſes of deafneſs; but the ſucceſs ſeems rather dependant on ſome concurrent circumſtances; either the time or mode of application, habitude of the patient, or ſtate of the diſorder; for we have alſo many other inſtances in which it has either been of very little ſervice, or totally failed. Mr. WILSON ſays, he afterwards repeated this method with ſix other perſons, but it was not attended with the ſame ſucceſs.

MR. FERGUSON likewiſe informs us that he cured a man who had loſt his hearing, by only twice drawing ſparks from his ears; and was afterwards as ſucceſsleſs with two or three others, whom he electrified in the ſame manner.

DROPSY.

'MARY BAKER, Chairwoman, aged 27, living at 'Mrs. HUNT's, in *Neal's-Yard*, near *Seven Dials*, having been long ill of a Dropſy, was admitted laſt year 'into St. *George*'s-Hoſpital. But, on *Nov.* 28, ſhe was 'diſcharged out of it, as incurable; as ſhe was alſo 'from the *Weſtminſter*-Infirmary. In ſpring laſt ſhe 'was electrified, and ſoon after parted with ſeveral 'gallons of water. After being twice more electrified 'ſhe was well, and able again to earn her living.'

[WESLEY's *Deſider.*]

THIS, I think, is the only caſe of a Dropſy, that I have met with, in which electricity has been apply'd. —The cure, as here recited by Mr. W. appears very extraordinary. In what *manner* the woman was electrified, he does not mention. His recital of many of the caſes is too laconic. To ſay, A perſon was *electrified* and *cured*, is ſomewhat like ſaying, He *recovered* by *taking Phyſic*.

EPILEPSY, and FITS of various Kinds.

CASE I. 'My Servant, C. P. had many years 'been afflicted with Hyſteric Fits. In 1761 I ſent 'her an Out-Patient to the Infirmary, which ſhe at'tended ſeveral months, but to appearance, with'out the leaſt good effect.' Her fits increaſed, and 'her conſtitution ſeemed much weakened. At laſt, I 'propoſed Electricity to her. She received ſeveral 'ſhocks, but not the leaſt good or ill effect could be 'perceived from them. Thinking with myſelf that I 'might have given the ſhocks at an improper ſeaſon, 'I changed the time, and gave them to her when the 'fit was upon her. The effect was now aſtoniſhing.

‘ The fit ceaſed. The convulſions were quieted, and ‘ ſhe was enabled in five minutes to go about her uſual ‘ work; whereas, when the fit was left to itſelf, it ‘ weakened her ſo much, that it was ſometimes near ‘ two days before ſhe recovered that little ſtrength, ‘ that the fits had left her. I purſued this method. ‘ Her fits gradually leſſened, and at length ceaſed.

‘ BUT I muſt here inform the reader, that in the ‘ ſpring 1762, I adviſed her to uſe the Cold Bath, ‘ which did her much good. This ſhe has continued ‘ every ſummer ſince, and at the writing this, *Dec.* ‘ 1764, ſhe continues in perfect health, and has had, ‘ from her own account, but ſix fits, and thoſe chiefly ‘ from ſurpriſe, ſince ſhe left off the uſe of electricity, which was from the time of her firſt uſing the ‘ Cold-Bath.

‘ I PASSED the ſhocks thro’ the heart, and from the ‘ right ſhoulder to the left ſide, and then from the ‘ left ſhoulder to the right ſide. When ſhe was much ‘ convulſed, I paſſed the ſhock from the left hand to ‘ the right foot, and then from the right hand to the ‘ left foot.’ [SYMES.]

CASE 2. ‘ SARAH BETTESWORTH, aged 22, then ‘ living in *Cow-Lane*, was ſome years ſince ſeized with ‘ ſo violent fits, that five or ſix men were ſcarce able ‘ to hold her. In autumn 1756, while ſhe was in one ‘ of them, ſhe was electrified. The phial was apply’d ‘ to one ſhoulder, as ſhe lay on the ground, and the ‘ wire to the other. On the firſt ſhock her ſtruggling ‘ ceaſed, and ſhe lay ſtill. At the ſecond her ſenſes ‘ returned. After two or three more, ſhe aroſe in ‘ good health. Some months after, ſhe relapſed, and ‘ was electrified again, and again entirely cured. Laſt ‘ Eaſter ſhe fell into a fit again, through a fright; ‘ but by a few ſhocks was cured, and reſtored to ‘ health. [WESLEY.]

CASE 3. ‘ WILLIAM MATTHEWS, Schoolmaſter, ‘ near *Moorfields*, aged 32, had *Epileptic* Fits (ſuppoſed to be hereditary) from his birth, till he was ſix ‘ years old. Thence he was free till thirteen. They ‘ then returned on occaſion of a fright, and continued ‘ ſo to do twice or thrice in a year, till he was ſeventeen. From that time they came almoſt every month, ‘ till the year 1753; ſince then they uſually returned, ‘ about once in ten or eleven weeks. In the middle ‘ of *March* laſt he began to be electrified, both through ‘ the head, and from head to foot. *April* 4, he had ‘ a ſlight fit; but from that time to this, *Nov.* 1, has ‘ had none at at all.

MR. W. aſks, ‘ Can all England afford ſuch a cure ‘ as this, wrought by a courſe of medicines?’

[DESIDER.]

CASE 4. ‘ A young Lady had been afflicted with ‘ fits near ſeven years, which ſeized her without any ‘ warning, and threw her on her face quite inſenſible. ‘ Theſe frequently returned twice in a day. This was ‘ attended with almoſt a continual coldneſs in her feet. ‘ Her ſtomach alſo was much affected. She was electrified by ſtanding upon a wire from the coating of ‘ a phial, and to complete the circuit, another wire ‘ was laid upon her head. By this means, both the ‘ fits and coldneſs were gradually removed, and a ‘ complete cure effected.’ [WESLEY, LOVETT.]

CASE 5. ‘ ELIZ. BUND, near the *Old Hills*, a few ‘ miles from *Worceſter*, had for fifty years been afflicted with ſevere fits, which, like an Epilepſy, gave ‘ her no warning, but threw down in an inſtant to the ‘ ground, and continued her in a ſtate of inſenſibility ‘ for a conſiderable time. She was attacked by theſe ‘ fits ſometimes twice or three times in a day. After ‘ being electrified, upon her return home, ſhe found ‘ ſuch a ſurpriſing amendment, as encouraged her to

‘ come to *Worceſter*, as often as ſhe had opportunity, ‘ in order to repeat the operation; the conſequence of ‘ which, was the gradual decreaſe of an inveterate ‘ Head-ach, which attended her diſorder; and, at ‘ laſt, the total ceſſation of the fits; for, inſtead of ‘ being ſeized with them twice or thrice a day, after ‘ ſhe had began theſe electrical operations, ſhe had ‘ no more than about four of them, and thoſe greatly ‘ weakened; and, as ſhe has none of them ſince *Chriſtmas*, 1753, there is ſufficient reaſon to hope they ‘ will not return. The operation was ſhocks chiefly. ‘ Signed *Sept.* 12, 1754.’ [ID.]

FROM the variety of cures, in Hyſteric and ſimilar caſes, which Mr. LOVETT effected by Electricity, he ſuppoſes it to be peculiarly ſerviceable in diſorders of this kind, but obſerves that, ‘ In theſe complaints, it ‘ is not to be done by *halves*; not for a few minutes ‘ only, (which is ſufficient in ſome others) particularly ‘ if it has taken deep root; but the perſon ought to ‘ ſtand or ſit on the electrified ſtool for an hour in the ‘ morning, and another in the evening each day; or, ‘ if two hours a day cannot be comply'd with, let ‘ it be two half hours; This may be firſt practiſed ‘ with ſometimes ſimply drawing off ſparks; afterwards with ſome ſlight ſhocks, and then, if the diſorder requires it, to be increaſed with more. Such ‘ proceeding I ſeldom found to fail of the deſired ‘ effects.’

FEET violently diſordered.

CASE I. ‘ JOHN WEBB, of *Worceſter*, ſeventy years ‘ of age, was much diſordered in his feet, for ten or ‘ twelve years. The pain reſembled that of the Gout, ‘ but ſuch a *coldneſs* attended it as was ſcarcely ſupportable. If he warmed them by the fire, they raged ‘ ſtill more, as alſo when he began to be warm in ‘ bed. The nails of his toes frequently dropt off:

‘ The toes in general appeared livid; and frequently ‘ large black, or bluiſh ſpots were formed on the ends ‘ of them, or on the top and ſides of his feet; and ‘ his heels were generally puffed up like blown bladders.

‘ ALL theſe complaints gradually decreaſed, till ‘ they were totally removed, by his being electrified ‘ once a day, for ſometime, and afterwards twice a ‘ week. At firſt only ſparks were drawn. Afterwards, the chain was brought from the outward ‘ coating of the phial, to the part affected of one foot; ‘ then one end of a wire was laid to the part affected ‘ of the other foot, and the other end of the wire ‘ brought to the conductor.’ [LOVETT.]

CASE 2. ‘ ESTHER HOPKINS, of *Tedney*, near *Worceſter*, was troubled with a very painful ſwelling, in ‘ the ball of her great toe, for ſome years. The pain ‘ was greateſt when ſhe was in bed. Having, in vain, ‘ made uſe of other means, ſhe came to *Worceſter*, to ‘ try the effect of electricity. After the firſt or ſecond ‘ operation, the pain was much abated; and ſhe told ‘ me, with pleaſure, ſhe had had a more comfortable ‘ night’s reſt than for a conſiderable time before. After continuing the uſe of electricity for a ſmall time ‘ longer, the ſwelling gradually aſſuaged, and the ‘ pain left her. The operation was ſetting her upon a ‘ cake of roſin, and drawing ſparks from the part affected.’ [ID.]

CASE 3. ‘ Mr. JOSHUA WADE, of *Perſhore*, was for ‘ ſeven or eight years troubled with a painful diſorder ‘ in one of his toes; and though it was tender as a ‘ boil, yet nothing was to be ſeen. The pain was ſo ‘ great that he was determin’d to have the toe cut off.

‘ THIS troubleſome malady was effectually cured at ‘ one operation; which was performed in the ſame ‘ as the above.’ [ID.]

FELONS.

IN an account from *Upſal*, in *Sweden*, by Dr. ZETZELL, we are informed that theſe are brought to a ſpeedy digeſtion, and cured, by drawing electrical ſparks from them: But no particular caſe is mentioned.

FISTULA LACHRYMALIS.

'ANNE THOMASON, in *Little Fiſh-ſtreet*, *Worceſter*, 'was troubled with a Fiſtula near the inner corner of 'her eye, which broke out and healed no leſs than 'ſeven times. The laſt time it healed, it continued 'well for ſome time; after which it began with a ſmall 'ſwelling, and continued growing larger, till it was 'as big as a filbert; when ſhe was adviſed to try electricity. After the ſwelling was electrified, it ſoon 'decreaſed, till it was entirely diſperſed; and has continued well for more than two years, without the 'leaſt ſymptom of any return of the diſorder.—The 'operation was ſimply drawing ſparks from the part 'affected.' [LOVETT.]

GOUT.

I FIND but few inſtances of the effects of electricity in this inveterate diſorder. Though, according to Mr. LOVETT, electricity has frequently been made uſe of, with great ſucceſs in it; and he is of opinion, that complaints of this kind, even tho' hereditary, would, in time, be found to give away, if not quite cured, by electrical treatment. He mentions his having made ſome trials on perſons ſlightly attacked by the Gout, who received benefit ſo ſuddenly, that they could ſcarcely think it to be the effect of electricity. He aſſerts the following

CASE I. 'A Perſon in *Worceſter* had, within the 'ſpace of two or three years paſt, ſeveral attacks of 'the Gout, ſince the firſt of which, he had always a 'ſtiffneſs and pain in the joint of one of his great toes,

‘ and for a conſiderable time, in both, particularly if ‘ he walked much. He was quite cured in a ſhort ‘ time, by having ſparks drawn from the part affected.’

CASE 2. ‘ The following remarkable caſe (ſays the ‘ Rev. Mr. SYMES) was not performed by myſelf, but ‘ by a friend, who particularly deſired that I would ‘ inſert it in my liſt. It is here introduced with ſanguine hopes that others would make trial of electricity in the ſame caſe; being thoroughly perſuaded ‘ that the remedy will be found, if not effectual, yet ‘ moſt certainly innocent. The ſhort of the relation ‘ is this. A young gentleman, fond of electricity, ‘ went to his Tinman's for ſomething he had beſpoke ‘ of him, who at that criſis was thought to be dying ‘ of the Gout in his ſtomach. He was deſired to go ‘ up ſtairs: As ſoon as the poor man ſaw him, Sir, ‘ ſays he, for GOD's ſake electrify me. The machine ‘ was brought, and ſeveral ſhocks were given through ‘ the ſtomach, where the pain was felt. The patient ‘ every time begged that the ſhocks might be ſtronger. ‘ At laſt a great quantity of wind came up, and he ‘ immediately cry'd out, “ I am better.” That night ‘ he reſted tolerably well. The Gout almoſt inſtantly ‘ ſhifted from his ſtomach to his feet. But next day ‘ making too free with himſelf, and drinking ſome ‘ ale, the Gout returned to his ſtomach. The ſhocks ‘ were repeated, and the patient's account was, “ I ‘ feel the Gout retire to my feet.” He was cured.— ‘ Some years after I ſaw him, converſed with him, and ‘ heard the above particulars from him.’

GRAVEL.

‘ THOMAS WILLIS, Chair-maker, aged 44, was for ‘ many years afflicted with the Gravel in his kidneys. ‘ He was electrified twice. After the ſecond time he ‘ parted with a large quantity of Gravel. He was

‘ electrified twice more, and has not found the leaſt ‘ complaint ſince.’ [DESIDER.]

I FIND no other caſe of the gravel, wherein electricity has been made uſe of, than this one—but, if the nature of the diſorder be conſidered with that of the remedy, thoſe obſtructions ariſing from gravel ſeem to be no improper ſubjects for electrical treatment; at leaſt, I think no ill conſequences can enſue from it, and it may be worth while to make trial of a few diſcharges of the phial, tolerably forcible, from the reins, or between the ſhoulders, to the feet.

HEAD-ACH.

ELECTRICITY has been of very conſiderable ſervice in violent Head-achs, as appears from the number of caſes we find recorded.

CASE I. ‘ Mr. HIGGINS, in *Lich-ſtreet*, *Worceſter*, ‘ troubled with a periodical Head-ach for near ſix ‘ weeks, from the top of his forehead, or right temple, ‘ down to his ear, which commonly began at five or ‘ ſix o'clock in the evening, and held till he went to ‘ bed, was cured in a few minutes.—The operation ‘ was drawing ſparks from the part affected.’

[LOVETT.]

CASE 2. ‘ M. DANCOCKS, near *Sidbury-Gate*, *Worceſter*, was afflicted with an almoſt conſtant and violent pain in the hinder part of her head, for near ‘ three quarters of a year; but worſt of all when ſhe ‘ firſt lay down in her bed, being then ſo intolerable, ‘ ſhe could not forbear ſhrieking. Having made uſe ‘ of all means in her power to no effect, was very ſoon ‘ relieved of the violence of the pain, by being electrified once a day; and, after continuing it ſome time ‘ longer, declared herſelf perfectly cured.’ [ID.]

CASE 3. ‘A. T. of *Whitechapel*, had a violent ‘Head-ach, which continued for ſeven or eight weeks. ‘After ſhe was electrified the pain increaſed for three ‘hours. It then gradually decreaſed, till ſhe was quite ‘well. This proves that electricity may remove even ‘a diſorder which, at firſt it ſeems to increaſe.’

[DESIDER.]

CASE 4. ‘A. BROWN, aged 22, was from a child ‘frequently afflicted with a violent Head-ach. In *Oct.* ‘1757, ſhe was electrified five days ſucceſſively; hav‘ing one wire apply’d to the fore part, another to the ‘hinder part of her head, and receiving ſeven or eight ‘ſhocks each time.’ Hereby ſhe was entirely cured, ‘nor has found any pain in her head ſince, unleſs oc‘caſionally for want of ſleep.’ [IBID.]

CASE 5. ‘SARAH WEBB, wife of Mr. WEBB, Tal‘low-chandler, aged 46, was from twenty years old ‘ſubject to a violent pain on the top of her head. ‘This frequently obliged her to keep her bed; nor ‘could any remedy for it be found. She was electri‘fied by gentle ſhocks from temple to temple, and ‘from the forehead to the back part of her head. ‘This was done three days ſucceſſively, and ſhe was ‘entirely cured.’ [IBID.]

CASE 6. ‘R. OUTEN, Rope-maker, aged 23, liv‘ing in *Bunhill-Row*, was troubled with a violent ‘*Head-ach* over the eyes, before he was ten years old, ‘ariſing from a blow on the head. He was ſcarce ‘free from it a month together, for above twelve ‘years. It uſed to throb and ſhoot through the head, ‘ſo that often he was almoſt diſtracted. He was ‘once electrified, receiving three ſhocks, by one wire ‘apply’d to the forehead, and another to the back ‘of the head. He was worſe than ever for ſome hours, ‘till he went to bed, but awaked in the morning per‘fectly well; and has continued ſo ever ſince.’

[IBID.]

In moſt of the foregoing caſes, the diſorder appears to have taken its riſe either from external injury, or ſome other extraordinary cauſe;—In a common head-ach, proceeding from indigeſtion, fatigue, &c. electricity ſeems to be of very little ſervice.

Hysteric Complaints, Depression, &c.

The ſalutary effects of electricity, in various caſes of this nature, have been very remarkable. We have ſeveral inſtances of perſons who have been entirely relieved of ſuch complaints, though of many years ſtanding, by repeating the uſe of electrical applications, in various modes, for the ſpace of a few months.

Mortification.

Mr. Lovett gives us one inſtance of a Mortification, which he had ſurpriſingly benefitted by electrical treatment. The patient was a gentleman of *Worceſter*. The complaint began in his toe, and the mortification proceeded, notwithſtanding every probable remedy was apply'd. At length he was electrified, and ſeveral charges of the phial ſent through the part. The mortification ſtopped; but, upon omitting the electricity, it began again, and increaſed ſo far that the caſe ſeemed deſperate. He was again electrified in the ſame manner, which, by the next morning, produced ſuch a change for the better as aſtoniſhed the Surgeon, who acknowledged it had done more good in two days, than had been effected in ſix weeks before.

Paralytic Disorders.

This appears to be an extenſive field for electrical operations, in which the ſucceſs has been extremely various. The benefit of electricity, in ſome of theſe complaints, has been remarkable,—in others, apparently ſimilar, it has been found of very little ſervice.

THE Rev. Mr. W. JONES, in his *Eſſay on* NATURAL PHILOSOPHY, relates the following remarkable cure.

CASE 1. 'A Girl of about twelve years of age, the 'daughter of a Shepherd in the pariſh of *Wadenho*, 'in *Northamptonſhire*, having frequently expoſed her-'ſelf in the field, to bad weather, was afflicted in the 'ſpring 1761, with flying pains in her limbs, ſoon 'followed by an *hemiplegia*, which ſeized her ſuddenly 'as ſhe was at work, and deprived her of the uſe of 'her limbs on the right ſide; ſo that ſhe was unable 'to ſtir from her chair. She complained alſo of a 'fixed pain toward the bottom of the ſpine, which 'became ſo violent, that, when in bed, ſhe could reſt 'in no poſture but with her face downward.

'To remove this ſymptom, a bliſter was recom-'mended to be laid near the part. It had the deſired 'effect, and removed this pain in a day or two; but 'her limbs, on the right ſide, were ſtill as uſeleſs as 'before, and ſo invincibly cold, that her mother was 'employed many times a day in rubbing them with 'hot flannels.

'THE bliſter was continued under the form of a '*perpetual bliſter:* But I found, after ſome trial, that 'no farther benefit was to be expected from it; and 'having but little hope from the uſe of any external 'medicines, I reſolved to electrify her.—The ſhock 'was given after the common method; only I endea-'voured to adminiſter it in ſuch a manner, that the 'fire, upon its diſcharge, ſhould follow the courſe of 'the nerves (from the top of the ſpine downwards) 'throughout the whole ſide that was affected. After 'two or three ſtrokes, of which ſhe complained but 'little, though they were very ſevere, I enquired, 'Whether ſhe perceived any warmth or tingling in 'her limbs? To which ſhe anſwered in the affirma-'tive. When ſhe had received about half a dozen

‘ ſtrokes, I diſmiſſed her, ordering her parents to wrap ‘ her up warm in bed immediately, and bring her to ‘ me again in a day or two.

‘ At her next appearance, ſhe was much altered for ‘ the better: Inſtead of that cold and numbneſs ſhe ‘ had before complained of, her limbs had a glowing ‘ warmth in them from the time ſhe had left me; and ‘ this was followed by a profuſe ſweating, which came ‘ on after ſhe was put to bed, and continued for about ‘ two days after the firſt operation. There was like‘ wiſe *a copious diſcharge from the bliſter*, which, for ‘ ſome days before, had produced no effect, and was ‘ in a manner dried up.

‘ After the *ſecond* operation ſhe continued to mend. ‘ After the *fourth*, ſhe went by herſelf, upon crutches, ‘ to a neighbouring houſe, at ſome little diſtance. At ‘ this time, the ſhocks began to hurt her ſo much as ‘ to make her ſhed tears; a plain proof, that her ‘ limbs had now, in a great meaſure, recovered their ‘ ſenſibility. After the *ſixth* operation, ſhe was able ‘ to walk up a ſteep hill to church, without any aſ‘ ſiſtance, even from a walking-ſtick: And during ‘ this whole courſe, no medicines of any kind were ad‘ miniſtered. Some weakneſs ſtill remained, which ‘ electricity would not remove; I therefore recom‘ mended the uſe of the cold bath, by the help of ‘ which ſhe ſoon recovered her ſtrength, and is now ‘ able to work for a livelihood nearly as well as be‘ fore, except that her right leg is ſomewhat ſhorter ‘ than the other, which, as ſhe walks, neceſſarily occa‘ ſions her to ſink a little on that ſide.

After reciting the above caſe, the ſame gentleman obſerves of medical electricity, from the opportunities he has had of trying its power, that, though it ought not to be haſtily cried up as a cure for all diſeaſes, (which has been the misfortune of many an uſeful remedy)

medy) ſome there certainly are, to which it may be apply'd with ſucceſs; and ſays, he ſhould be glad (and every benevolent mind will wiſh with him) to ſee its uſefulneſs properly aſcertained, and diſcreetly limited, by ſome candid and judicious gentlemen of the faculty. He farther obſerves, that, from what has appeared to him, he believes it might be of much ſervice in *rheumatic pains*, and *paralytic affections*, where they are recent, and the patient not too far advanced in years. Some of the principal diſorders ariſing from *obſtructions* (he adds) might find great help from it, if taken in time: And he ſuppoſes it might be worth while to try it in the caſe of a *gutta ſerena*, or any other diſorder that may be referred to this claſs, which is a very numerous one.

BUT he thinks, its greateſt efficacy will be found in removing (and that in a very ſmall ſpace of time) all *ſpaſms* or *cramps*, particularly ſuch as proceed from any ſudden *cold* upon the external parts; and ſuppoſes it highly probable, that in the moſt extreme caſes of this kind, immediate relief might be expected from it, even in that dreadful ſpaſm which affects the muſcles of the back or breaſt, and is ſo common both in the *Eaſt* and *Weſt-Indies*. This diſorder is deſcribed by BONTIUS, in his *Hiſt. Nat. & Med. Ind. Orient.* p. 18. "*Tam repentinus & ſubitus eſt aliquando ejus impetus*" &c. The ſame ſpecies of diſorder, I apprehend, which is uſually called a *tetanus*. Mr. JONES, here, undoubtedly appears to be right in his conjecture, for a tetanus has been cured by electrical treatment.[u]

WHAT led him to believe that electricity might be of the utmoſt ſervice in this frightful diſtemper, was the caſe of one of his maid-ſervants, who, by taking cold in the night, aroſe in the morning with that ſpaſm commonly called a *crick* in the neck; ſo violent, that her

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[u] See p. 76.

her head was drawn aſide toward one ſhoulder, and could not be moved any way without cauſing an acute pain. He ordered her to be placed on a ſtand, ſupported with glaſs feet, and drew ſparks from the part where the greateſt pain was felt, when ſhe attempted to move her head. By this means, in a minute or two, her head came nearer to its right poſition, and by continuing the operation, was very ſoon reſtored. Some ſoreneſs remained in the part; which was removed by keeping her neck warm. All the ſparks that were drawn raiſed ſo many little red puſtules or bliſters; which is not uſual if the part be in a healthy ſtate. But, to return from this digreſſion from paralytic diſorders.

Case 2. ‘ Joseph Burges, aged 22, applied to me ‘ in *Feb.* 1761. Two years before, returning from ſea, ‘ he was impreſſed into the King's ſervice, in the *Briſtol* ‘ channel, and with ſeveral others was ſent to navigate ‘ a prize round to *Plymouth*. He had not been long ‘ on board, before he was ſtruck with a *hemiplegia* on ‘ the right ſide. When the Veſſel arrived at *Plymouth*, ‘ he was ſent to the Hoſpital. He continued there, his ‘ mother informed me, three months, without receiv‘ing the leaſt benefit. She then removed him to *Briſ*‘*tol*, and by the help of friends, got him admitted ‘ into the Hoſpital at *Bath*, where he remained ſeven ‘ months, but to no purpoſe. She then removed him ‘ back to *Briſtol*, and got him admitted into the Infir‘mary, where he continued three months, and was ‘ then diſmiſſed as incurable.

‘ Some time after this, his mother applied to me; ‘ at this criſis, his right leg was almoſt uſeleſs, he had ‘ no ſtrength to lift it up, he could only drag it after ‘ the left. His right arm was wither'd, and ſeemed ‘ only to hang to his ſhoulder, and his fingers were ‘ faſt clenched, and quite inflexible; nor was he able

‘ to ſpeak one articulate word. I gave him 30 or 40
‘ ſmart ſhocks for ſeveral mornings, and had ſoon ſuf-
‘ ficient reaſon to think that I ſhould be of ſervice to
‘ him; for the parts, which were at firſt inſenſible,
‘ began to recover their feeling, his fingers unclench-
‘ ed a little, and looked of a living colour. In two
‘ months his leg recovered ſo much ſtrength, that he
‘ could walk with freedom; and I could perceive the
‘ fleſh of his arm grow and increaſe apace; by this
‘ time he could lift it to his head, and move his fin-
‘ gers. I ordered him to uſe his arm as much as he
‘ could. In a little time he recover'd ſo much ſtrength,
‘ that he was able to work at a pump for half an hour.
‘ He attended three months, and then of his own ac-
‘ cord left me. His fleſh became ſenſible, and the
‘ ſhocks gave him pain, which was the reaſon of his
‘ coming no more.’ [SYMES.]

MR. SYMES adds, that the man, ſoon after, went to work in a brick-yard, and that in the year 1766, he ſaw him at work, wheeling a barrow, which, by the help of a ſtrap round his wriſt, he ſeemed to manage as well as his fellow-labourers. Some of his fingers were ſtill rigid and contracted; and he was able to articulate but few words. Had he continued the uſe of electricity, Mr. SYMES apprehends he might have been perfectly cured.

CASE 3. MR. LOVETT gives us an account of a cure which he performed on a perſon who had a ſudden ſtroke of the palſy in his arm, which remained uſeleſs for ſome time, but was reſtored by means of friction. The ſtroke was repeated a ſecond, and a third time; when he was effectually cured by few electric ſhocks.

THE ſame perſon had lately a much worſe ſtroke of the ſame kind. All the right ſide was ſo affected, that he could not walk without the aſſiſtance of two perſons to ſupport him. After he had been electrified a few times, he was able to walk with the help of one perſon, and in three weeks was perfectly reſtored.—The operation was ſhocks from the right hand, to the right foot.

CASE 4. 'THOMAS DOBSON, Leather-pipe-maker, 'aged 27, was ſeized with a palſy in the tongue. It 'continued to grow worſe for ſome days, and then 'quite deprived him of his ſpeech. He was electrified 'for five days, by drawing ſparks from the tongue, 'and ſhocking him all over. By this means not only 'his palſy was cured, but convulſions alſo, which he 'had had for four years.' [DESIDER.]

MR. WESLEY, in his *Deſideratum*, written about twelve years ago, acknowledges that he had not himſelf, at that time, known any inſtance of the perfect cure of a *hemiplegia*; 'Many *paralytics* (he ſays) have 'been helped, but I think ſcarce any palſy of a year's 'ſtanding, has been thoroughly cured.'

THIS melancholy diſorder, perhaps above any other, requires a moſt judicious treatment.—The following caſe ſeems to be an inſtance of an injudicious application of electricity. Dr. HART, of *Shrewſbury*, in a letter to Dr. WATSON, ſays, 'A young girl, about 'ſixteen, whoſe right arm was paralytic, on being 'electrified the ſecond time, became univerſally para'lytic, and remained ſo about a fortnight, when the 'increaſed palſy was removed by medicines which her 'caſe indicated; but the firſt diſeaſed arm remained 'as before: I ſhould have mentioned too, that this 'arm was greatly waſted, in compariſon of the other. 'However, notwithſtanding the former bad accident, 'I had a mind to try the effect of electricity on her 'again, which we renewed; and, after about three 'or four days uſe, ſhe became, the ſecond time uni'verſally paralytic, and even loſt her voice, and with

‘ difficulty could ſwallow. This confirmed me in my ‘ opinion, that the electrical ſhocks had occaſioned ‘ theſe ſymptoms.—We therefore omitted it, and the ‘ girl, though ſhe grew better of her additional palſy, ‘ for ſo I call it, remained as bad as before of her ‘ firſt.’ [Phil. Trans. Vol. 48. 1754.]

This appears, pretty clearly, to be one inſtance that electrical treatment improperly apply’d, may be attended with ill effects; and I think it is the only one worthy of notice, that I have met with.—From the conſequences which enſued from Dr. Hart’s method of electrifying, we may very reaſonably conclude that the ſhocks were too violent. Though the Doctor was, no doubt, a man of diſcernment, it ſeems very probable that he did not ſufficiently attend to the particular circumſtances of this poor girl’s caſe. Perhaps the number of patients, and variety of buſineſs in an *Hoſpital* (where, I think, electricity is not likely to receive its laſt improvement) might oblige him to proceed with leſs precaution than ſuch an experiment required. The complaint was in the arm only; and the arm alone ſhould firſt have been ſhocked. At that time, indeed, it was not known, at leaſt it does not appear to have been ſufficiently attended to, that a large quantity of the electric fluid, inſtantly tranſmitted through any part of the body, would affect the whole, and be productive of one rude concuſſion (properly termed a *ſhock*) throughout the whole frame,—and that a quantity more moderate, would affect little more than the part which lay immediately in its circuit or paſſage.—But this was *the trial of a new remedy*, on a patient of the lower claſs.

Dr. Hart ſeems to have been generally pretty liberal in the uſe of his medicine, and never ſtinted his patients in quantity. In a preceding part of his letter to Mr. Watson, he mentions the caſe of another woman,

man, whoſe arm had been paralytic for ſome years, ſo as to be ever abſolutely motionleſs, and inſenſible of heat, cold, or pain; and ſays that the *greateſt blows* were given to it for many days ſucceſſively—it is much that this woman was not likewiſe *univerſally paralytic*—but, notwithſtanding this rough treatment, the arm, it ſeems, grew better, and ſhe recovered ſome little uſe of it.

Dr. Franklin ſeems likewiſe, in ſome meaſure, to have fallen into this miſtake, of ſuppoſing that a large quantity of the electric matter, and very forcible exploſions were neceſſary to be made uſe of in this diſorder. In a letter to Dr. Pringle, read at the Royal Society in *Jan.* 1758, he ſays, that a few years before, when the news-papers made mention of ſeveral conſiderable cures performed in *Italy* and *Germany* by electricity, a great number of *paralytics* were brought to him, from different parts of *Penſilvania*, and the neighbouring provinces, to be electrified. His method was, after placing the patient on an inſulated ſtool, to draw a number of ſtrong ſparks from all parts of the affected limb or ſide. He then fully charged two ſix gallon glaſs jars, each containing about three ſquare feet of coated ſurface, and ſent the united *ſhock* of them through the affected limb or limbs, repeating the ſtroke commonly three times each day.

By this treatment moſt of the patients appeared to be relieved, for a few days; a greater ſenſible warmth was obſerved in the affected limbs, which were found more capable of voluntary motion, and ſeemed to acquire more ſtrength. Theſe appearances, he ſays, gave great ſpirits to the patients, and made them hope for a perfect cure; But he did not remember to have ſeen any amendment after the fifth day.—The *ſhocks* became ſevere—the patients were diſcouraged—went home, and in a ſhort time relapſed.

IF, inſtead of *two ſix gallon jars*, the Doctor had made uſe of only one of *two quarts*, and proportioned the ſhocks as the patients were able to bear them, at the ſame time uſing a gentle external friction with flannels, oils, &c. the benefit, perhaps, might have been much more permanent. Indeed he himſelf afterwards ſuppoſed that many ſmall ſhocks would have been more proper than the few large ones he gave; having read, in an account from *Scotland*, of a caſe in which two hundred ſhocks (or rather ſmall diſcharges) from a phial were given daily, and a perfect cure had been made.

MR. JAMES FERGUSON, in his Treatiſe on electricity, relates a remarkable cure of a *Hemiplegia* performed by MR. WM. SWIFT, of *Greenwich*. The patient was the Wife of MR. ALLMEY, a Baker. The affected ſide was totally inſenſible. DR. GREEN, who attended her, ordered her to be electrified; which was done by drawing of ſparks, ſometimes for more than an hour together, and then proceeding to the uſe of the charged phial. The diſcharges were made pretty ſtrong till ſhe began to feel them, and then more moderate. The operation was begun *Sept.* 3, 1769, and continued till the 18th of *Oct.* following, in which time ſhe was electrified for the ſpace of 31 hours, at 18 different times, and had received 141 ſhocks. She was hereby quite reſtored.

UPON the whole we find that electricity has been of ery conſiderable ſervice in this diſorder; but the ſuc- ſs appears greatly to depend on a proper and well ned application; and I think, not only the *degree* and *ration* of the diſorder, but the ſtrength and conſtitu- on, the age, ſex, and habitude of the patient, ſhould ſo far conſidered as in ſome meaſure to determine the de of operation.

RHEUMATISM.

THE general method of treating *rheumatic* complaints and fixed pains in the limbs, proceeding from colds &c. is firſt drawing of ſtrong ſparks from the affected parts, and then making uſe of the coated phial. The former method alone, has often been known to remove rheumatic pains of many years ſtanding; and in many caſes of this ſort, a few electric ſhocks has effected cures after other remedies had been uſed to no purpoſe.

SCIATICA.

CASE 1. ‘ Mr. JOHN ELLISON, an Officer of the ‘ Exciſe, living in *Hunt-ſtreet*, *Spitalfields*, was upon ‘ catching cold, ſeized with a violent *Sciatica*, which ‘ held him ſeveral months without intermiſſion, and ‘ frequently almoſt took away the uſe of his limb. In ‘ *Aug.* 1754, he was electrified, receiving two ſhocks. ‘ His pain was greater for four or five hours, but afterwards entirely ceaſed, and returned no more.’

[DESID.]

CASE 2. ‘ MARY BUTLER, aged 86, of *Eagle-ſtreet*, ‘ *Red-Lion-Square*, had been afflicted with a *ſciatica* for ‘ more than twenty years, ſhe was electrified ten or a ‘ dozen times, and has been eaſy ever ſince.’ [IBID.]

CASE 3. ‘ A Lad who had a ſevere *ſciatica* in the ‘ right hip, from a fall from a ſcaffold, ſo as not to ‘ bear being touched, was ſo far cured by electricity in ‘ a few days, as to be able to walk without a ſtaff.’

[LOVETT.]

CASE 4. ‘ THOMAS FRANKLAND, an Invalid, but ‘ diſcharged on account of what was thought an incurable malady, was ſeized with a violent and moſt excruciating pain in the upper part of his thigh. It had ‘ tormented him for three months before he came to me,

‘ and had rendered his life perfectly miſerable. He was ‘ cured by electrifying him only twice. I paſſed about ‘ ſix ſhocks through the pain. This poor fellow's gratitude was ſo great that, at whatever diſtance he ſaw ‘ me, he would always run and be ready to throw himſelf at my feet. [SYMES.]

SORE THROAT.

CASE I. ‘ ELIZ. TAYLOR, of *Hennick's-Hill*, near ‘ *Worceſter*, after taking cold, was ſeized with a ſore ‘ throat, which continued growing worſe for the ſpace ‘ of ſix days; at which time ſhe could not ſwallow even ‘ a bit of bread ſoaked in tea. She came to *Worceſter* ‘ to try the effect of electricity, and received ſo much ‘ benefit from it, that, by the time ſhe got home, ſhe ‘ was able to eat ſome boiled mutton. After being ‘ electrified twice more ſhe was perfectly cured.—The ‘ operation was ſmall ſhocks, from one ſide of the ‘ throat to the other.’ [LOVETT.]

CASE 2. ‘ I was once, at *Briſtol*, ſeized with a ſore ‘ throat, ſo that I could not ſwallow any thing. Mr. ‘ ADLAM, of that city, who is a fine electrician, came ‘ and drew many electric ſparks from my throat; and ‘ in about half an hour after, he did the ſame again. ‘ He ſtay'd with me about an hour longer, and before ‘ he went away, I could both eat and drink without ‘ pain; and had no return of the diſorder.—I have re‘lieved ſeveral perſons in ſuch caſes, but never in ſo ‘ ſhort a time as Mr. ADLAM cured me.’ [FERGUSON.]

I HAVE frequently had the ſatisfaction of proving the good effects of electricity in this complaint, both on myſelf and others.—I never made uſe of the coated phial in this caſe, but drew very ſtrong ſparks from different parts of the throat and neck, by means of an inſulated diſcharging rod, in contact, by means of a chain, with the *negative conductor*. I always found this method attended with ſucceſs, if the operation was performed ſoon after the firſt ſymptoms of the diſorder appeared.

SPRAINS, SWELLINGS, &c.

CASE 1. ‘ JOHN PAGLAR, Maſon, being at work ‘ in *Redcliff-ſtreet*, March 1762, had the misfortune, ‘ by carrying a Stone too heavy, to wrench his knee; ‘ it ſwelled immediately, and was very painful.—He ‘ apply'd to a ſurgeon, who told him, he imagined it ‘ would be ſome time before it would be cured. The ‘ next morning he came to me, but with great difficulty and much pain. I paſſed about five ſhocks thro' ‘ the ſwelling; this enabled him to bend his knee, and ‘ walk about the room without difficulty. I ordered ‘ him to favour his knee that day as much as he could, ‘ and come to me the next morning. He came, but ‘ perfectly cured with what was already done. The ‘ ſwelling was gone, and he could bend his knee and ‘ walk as well as ever.’ [SYMES.]

CASE 2. ‘ JACOB GRIFFITH, a ſea-faring man, apply'd to me *May* 21, 1765, to electrify him for pains ‘ and ſwellings in his legs and arms. He told me that ‘ he had been diſcharged from the HOPE Man of war, ‘ as incapable of ſervice, and that he had likewiſe been ‘ diſmiſſed from the *Portſmouth* hoſpital, as incurable. ‘ He was cured by ſhocks, attending only four days.’ [ID.]

CASE 3. ‘ S. W. in the year 1762, had the miſfortune to cut her hand with the edge of a tin box. ‘ The wound was trifling, but, in a day or two it grew ‘ painful. An eminent ſurgeon dreſſed it. It grew ‘ worſe; and at laſt became ſo bad, that it was concluded, in order to ſave her life, ſhe muſt loſe her ‘ hand.—After repeated applications, however, they ‘ ſucceeded ſo far as to heal the wound. In the ſummer ‘ 1765, ſhe was directed to me. I do not remember

‘ ever to have ſeen a hand ſo diſtorted. It was much ‘ waſted, as was alſo her arm. She was always in pain, ‘ and her fingers and hands had loſt all feeling.

‘ HAVING never had a caſe ſimilar to this, I could ‘ not give her much encouragement. I could only ſay ‘ that no one could poſitively declare what electricity ‘ would not cure, broken bones excepted.

‘ HER feeling was ſo loſt, that at firſt ſhe did not ‘ perceive the ſhocks in her hand, though I gave her ‘ ſeveral ſmart ones. The fourth morning ſhe began ‘ to feel; this encouraged me.—In ten days there was ‘ a manifeſt appearance for the better: Her pain was ‘ taken off, and her hand and arm were ſo ſtrengthened that ſhe could lift a chair. After this her joints ‘ began to appear, and her fingers to be flexible; for ‘ before, there was no bending in her fingers, nor a ‘ knuckle to be ſeen.—She told me ſhe could feel the ‘ fineſt needle, and uſe it with eaſe; the ſhape of her ‘ hand alſo was much altered for the better.’ [ID.]

CASE 4. ‘ The wife of Mr. EVANS, Corn-chandler, of *Briſtol*, had a fixed and ſharp pain in the ‘ ſmall of her back, cauſed, as ſhe apprehended, by ‘ frequent miſcarriages. No coſt had been ſpared to ‘ obtain a cure: The ableſt phyſicians had been conſulted, and the Bath had been tried. When ſhe came ‘ to me to be electrified, ſhe ſaid ſhe had not lain down ‘ in her bed for a twelvemonth, but was obliged to be ‘ bolſtered up; and if at any time ſhe fell in her ſleep ‘ on one ſide, ſhe was awakened with a pain, as if ‘ needles were piercing her.

‘ I PASSED four ſhocks through the place where the ‘ pain was fixed. The next morning ſhe came to me ‘ full of ſpirits, telling me ſhe had lain down in her ‘ bed, had ſlept ſoundly, and that the pain was almoſt ‘ gone. I paſſed four ſhocks more through the pain;

‘ and ſhe felt no more of it then; but taking too great ‘ liberty with her new-acquired ſtrength, and lifting ‘ ſomething too heavy for her, her pain returned, but ‘ not with violence.—A few ſhocks removed it.’ [ID.]

CASE 5. ‘ Mrs. H. Wife of Mr. H. in *Pipe-Lane*, ‘ for five years had been ſo afflicted with acute pains in ‘ her left leg and right arm, that her life was rendered ‘ quite miſerable. Her leg was ſo benummed, that it ‘ had loſt its feeling.—When ſhe was brought to me, ‘ *May* 6, 1765, ſhe was ſo weak, that it was with ‘ difficulty ſhe was kept from fainting; but notwith‘ſtanding ſhe was thus reduced, in five days, by the ‘ help of two perſons, ſhe was able to walk to my ‘ houſe. The ſhocks removed her pains almoſt imme‘diately, and the ſecond day of her attendance, the ‘ numbneſs was taken off, and ſhe began to perceive a ‘ feeling in her leg. After attending about twenty ‘ times, ſhe was perfectly cured.’ [ID.]

CASE 6. ‘ In *February* 1765, my wife, after lying‘in, was ſeized with an almoſt total loſs of the uſe of ‘ her limbs. Not a joint was free from excruciating ‘ pain. She appeared ſo bad that bliſters were judged ‘ needful. Accordingly two were applied to the ſmall ‘ of her legs. When ſhe was able to ſit up in bed, ‘ ſhe begg'd I would electrify her. Her knees ſwelled, ‘ her ancles ſpread, and not a joint in her hands but ‘ what was enlarging. The effects of the ſhock was ‘ ſurpriſing; it reduced the ſwellings, took off her pains, ‘ and cauſed her to have good nights. But what is ‘ remarkable, ſuch a deadneſs fell on the places where ‘ the bliſters were put, that for a long time ſhe had ‘ not the leaſt feeling in the ſmall of her legs. I have ‘ the greateſt reaſon to believe that electricity, un‘der GOD, preſerved her life; for beſides what I have ‘ mentioned, there were ſtrong ſymptoms of a dropſy. ‘ I paſſed the ſhocks through her pains, and ſometimes 'ſhocked her whole frame, giving the ſhock from 'hand to foot. Theſe ſhocks, ſhe ſaid, did her moſt 'good. She recovered. But a weakneſs continued in 'her legs and ancles. A Cramp teaz'd her for a long 'time after, but electrifying always relieved her. [Id.]

Case 7. 'Wm. Rowe, ſecond-mate of the *Glo-'ceſterſhire*, from an injury he received in being bled 'in his arm, had ſo painful a ſwelling there, that he 'had ſcarcely any ſleep for ſix weeks. Every neceſſary 'remedy was apply'd, but he received no benefit.—'He came to me *July* 6, 1761; he was then in great 'miſery. The ſwelling was very large, and ſo hard 'that I could not make the leaſt impreſſion on it with 'my finger. His hand was withering, and the whole 'arm ſo weak, that he was obliged to reſt it in a ſling. '—I gave him between thirty and forty ſhocks the 'firſt time. The night following he ſlept better than 'he had done from the time of bleeding, and ſaid that 'the pain was nearly taken off. I perceived the ſwel-'ling to be abated one third. I gave him as many 'ſhocks as the day before; and, to my great aſtoniſh-'ment, when he went from the machine, he took his 'ſling, which was a ſilk handkerchief, from his neck, 'and put on his coat with eaſe. He was perfectly 'cured in about three weeks. I paſſed the ſhocks 'chiefly through the ſwelling, and from the ſhoulder 'down to the hand.' [Id.]

Case 8. 'The Wife of Mr. Price, Blackſmith, 'in *Briſtol*, had been for ſome time confined to her 'room, by what the apothecary judged to be a *White 'Swelling* in the knee, and of a very dangerous na-'ture.—She was brought to my houſe in a chair, I 'paſſed ſeveral ſhocks through the ſwelling, and from 'the knee down to the foot. Her pain, which was 'very great, was ſoon taken away, and in a month's 'time ſhe was able, by the help of a crutch, to walk

‘ to my houſe. She was perfectly cured in three ‘ months.’ [ID.]

CASE 9. ‘ FR. HALFPENNY, Taylor, in *Redcroſs-* ‘ *ſtreet*, *Southwark*, when about 18 years of age, had ‘ a fall from a tree. By this he received ſo violent a ‘ ſprain, that he could not walk twenty yards, unleſs ‘ exceeding ſlow, without a gnawing, aching pain ‘ down his thigh. In *Sept.* laſt he was electrified ‘ through the upper part of the thigh. This was re- ‘ peated at five or ſix different times. The firſt ſhock ‘ removed the pain down to the knee. At the third ‘ electrifying it went quite away. And ſince that time ‘ he has been perfectly well.’ [DESIDER.]

I MIGHT innumerate a variety of other cures effected by electricity, not leſs remarkable than any of the above, from ſeveral other writers, and many more that are recent in this City; but I have already exceeded the limits I intended for the particular caſes; I was led on by the conſideration that ſome perſon or other, might probably meet with a caſe ſimilar to his own, and to ſuch I imagin'd the relation might appear in ſome meaſure intereſting.

WHILE I was writing ſome of the above caſes, an obſervation or two occurred to me which, tho' perhaps of no great conſequence, may not be amiſs to mention, as every particular effect of electricity ſeems to be worthy of notice.

ONE circumſtance attending ſome of the preceding cures, particularly that of the *paralytic*, related by Mr. JONES,[w] was a freſh and copious diſcharge of the *bliſters* which had previouſly been apply'd to the patients. —This, I think, ſeems to be a pretty general conſequence of electrification; at leaſt I have myſelf known many inſtances of it; particularly in one gentleman, whom I electrified for a paralytic complaint, and who had a bliſter apply'd to the back part of his neck. He informed me, that, in the nights after his being electrified the preceding day, he found a much more copious diſcharge from the bliſter than at other times; though the operation was no more than his ſtanding, for about a quarter of an hour, on the inſulated ſtool, while ſparks were drawn from the ſide of his face.

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[w] See page 89.

FROM hence it appears not improbable, that, in ſome caſes, bliſters may be attended with peculiar benefit, during a courſe of electrical treatment; in others, perhaps, it might be worth while to make uſe of electricity, merely to obtain a favourable diſcharge from the bliſters.

I HAVE alſo obſerved, that a copious *perſpiration* is frequently an effect of electricity, particularly when the coated phial is made uſe of. This, indeed, may partly proceed from the apprehenſion, generally awakened in the patient, of experiencing a diſagreeable ſenſation, which occaſions a more than ordinary exertion of the faculties, as well as from the action of the fluid itſelf; but I have ſometimes been led to think, that this circumſtance is ſo far from being unfavourable, that, in many caſes, it contributes to accelerate the cure.

I SHALL obſerve of the preceding caſes in general, that they appear to be a ſimple narrative of facts, related by men whoſe principal motive in writing on the ſubject, ſeems to have been benevolence; and who, I think, could by no means have been intereſted in exaggerating their accounts.

WE may, at leaſt, from hence conclude, that an electrical treatment of various diſorders, ſtrongly claims the attention of thoſe who have leiſure and abilities to inveſtigate its mode of operation. It is from ſuch pens —it is from the calm and liberal enquirer, diveſted of the prejudice of *hypotheſes*,—that we are to expect the advancement of genuine ſcience. When the nature and effects of the electric fluid have been duly enquired into; its analogy to ſome other articles of the Materia Medica pointed out, and the moſt conſiſtent method of application determined, we have great reaſon to expect it will be attended with very conſiderable and extenſive uſe.

THE chief *deſiderata* ſeem to be, the diſtinguiſhing of ſuch diſeaſes as are moſt proper for electrical treatment,—and applying it, at a favourable criſis, in the moſt effectual manner: But the vague and deſultory method in which electricity has generally been made uſe of, has frequently rendered the ſucceſs of the operation precarious.

I AM ſenſible it is not from a recital of the *cures* which have been effected by electricity, that this method of treating diſeaſes is likely to become adverted to; but rather from a rational conviction of its utility. —The Phyſician who has formed his ſyſtem of drugs, and whoſe rules of practice are eſtabliſhed by reaſon and experience, will poſſibly impute thoſe cures to *a favourable concurrence of circumſtances*, rather than to the effects of a medicine which, perhaps, he has not thoroughly examined. He will, doubtleſs, alſo obſerve, that ſome of the preceding caſes are liable to *exceptions*; Others, in which electricity appears to have been the principal, if not the ſole agent concerned in the cure, may ſtill be ſaid to be *facts without demonſtration*;—they appear to be wrapp'd in an air of *myſtery*, and the agent is of too ſubtile a nature to be the ſubject of analyſis.———Time and induſtry, however, may poſſibly ſo far unfold the veil, as to diſcover to us in a clearer light, the connection between the *cauſe* and *effect*; and that the action of the electric fluid, may be conſidered as a ſimple *remedy of nature*, in many of her diſorders.

I might have been a tacit advocate for medical electricity, merely from obſerving its beneficial effects in ſuch caſes as I have been an eye-witneſs to; but I ſhould ſcarcely have hazarded my ſentiments on the ſubject to public view, if I had not found them corroborated by thoſe of many ſenſible and ingenious men, whoſe inveſtigations and experiments are not ſo liable to deception: I ſhall therefore take the liberty of concluding this ſubject with a few extracts from the Rev. Dr. Priestley's *Hiſtory of Electricity*; in one ſection of which he has exhibited the ſentiments of different writers on the ſubject; and has ſelected and arranged his materials, with the ſame candour and perſpicuity which diſtinguiſh the other parts of his work.

SECT. IV.

Extracts from Dr. Priestley's *Hiſtory.* Period X. Sect. XIV.

Of Medical Electricity.

THE ſubject of medical Electricity falls almoſt wholly within the period of which I am now treating. For, though ſome effects of electricity upon animal bodies had been noted by the Abbe Nollet; and a few diſeaſed perſons had ſaid they had received benefit from being electrified; yet very little had been done this way, and phyſicians had ſcarcely attended to it, till within this period; whereas electricity is now become a conſiderable article in the *materia medica.*

The firſt account I have met with of the application of electricity to medical purpoſes is that of Mr. C. Kratzenstein, profeſſor of medicine at *Halle*; who, in the year 1744, cured a woman of a contracted finger in a quarter of an hour. He alſo ſo far relieved a perſon who had two lame fingers, by once electrifying them, that he could play upon the harpſichord, which he had before been diſabled from doing. He alſo obſerved, that a man's pulſe, which had beat eighty in a ſecond before he was electrified, immediately after beat eighty-eight, and was preſently increaſed to ninety-ſix.

There is another celebrated inſtance of the cure of a palſy before this period; which is that performed by Mr. Jallabert, profeſſor of Philoſophy and Mathematics at *Geneva*, on a Lockſmith of the age of fifty-two, whoſe right arm had been paralytic fifteen years, occaſioned by a blow of a hammer. He was brought to Mr. Jallabert on the 26th of *Dec.* 1747, and was almoſt completely cured by the 28th of *Feb.* 1748. In this interval he was frequently electrified, ſparks being taken from the arm, and ſometimes the electric ſhock ſent through it. Mr. Jallabert's own account of this cure is very circumſtantial.

The report of this cure performed at *Geneva*, engaged Mr. Sauvages of the Academy in *Montpelier*, to attempt the cure of paralytics, in which he had conſiderable ſucceſs.—The concourſe of patients of all kinds, which the report of theſe cures brought together, was prodigious. For two or three months together, twenty different patients were electrified every day. It is not ſurpriſing to find, that the neighbouring populace conſidered theſe cures as an affair of witchcraft, and that the operators were obliged to have recourſe to their prieſts to undeceive them. In the courſe of theſe experiments it was found, by very accurate obſervations made with a pendulum, that electrification increaſes the circulation of the blood about one ſixth.

One of the firſt who attended to electricity in a medical way, was Dr. Bohadtch, a Bohemian; who, in a treatiſe upon medical electricity, communicated to the Royal Society, gave it as his opinion, after the reſult of much experience, that of all diſtempers, the *hemiplegia* ſeemed to be the moſt proper object of electricity. He alſo thought it might be of uſe in intermitting fevers.

THE PALSY having happened to be the firſt diſorder in which electricity gave relief, there was a conſiderable number of caſes publiſhed pretty early, in which the paralytics were ſaid to have found benefit from this new method of treatment. In the year 1757 Mr. PATRIC BRYDONE performed a complete cure of a hemiplegia, and, indeed, an almoſt univerſal paralytic affection, in about three days. The patient was a woman, aged 33, and the palſy was of about two years continuance. And J. G. TESKE, very nearly cured a young man, of the age of 26, of a paralytic arm, of which he had not the leaſt uſe from the age of five years.

THE Abbe NOLLET's experiments upon paralytics had no permanent good effect. He obſerves however that, during fifteen years that he had electrified all ſorts of perſons, he had known no one bad effect to have ariſen from it to any of them.

DR. EDWARD SPRY relates a complete cure which he had made of a *locked jaw* and *paralyſis*, in the caſe of a girl of 18 years of age. Small ſhocks were given to the muſcles particularly affected.

THAT there is an intimate connection between the ſtate of electricity in the air and the human body, is evident from ſeveral facts, particularly a very remarkable one related by the Abbe MAZEAS, in a letter to Dr. HALES, of a man who was ſubject to epileptic fits. He was much more affected when it thundered than at any other time; and if it ever happened, which it rarely did, that he then eſcaped; his eyes, his countenance, and the confuſion of his expreſſions, ſufficiently demonſtrated the weakneſs of his reaſon. It was not the *fear* of the thunder that affected him, but he found a fatal connection between that phenomenon and his diſtemper; and, when the fit ſeized him, he perceived a vapour riſing in his breaſt, with ſo much rapidity, that he loſt all his ſenſes before he could call for help.

MEDICAL electricity is very much obliged to the labours of Mr. LOVETT, Lay-clerk of the Cathedral church at *Worceſter*, who has for many years been indefatigable in the application of electricity to a great variety of diſeaſes. His ſucceſs has been very conſiderable, and all the caſes he has publiſhed ſeem to be well authenticated. According to this gentleman, electricity is almoſt a ſpecific in moſt caſes of *violent pains*, of however long continuance; as in obſtinate *head-achs*, the *ſciatica*, the *cramp*, and diſorders reſembling the *gout*. He had no trials of the proper gout, but only on thoſe who were ſlightly attacked, and who received immediate relief.

THE *tooth ach*, he ſays, is generally cured inſtantly, and he ſcarce ever remembered any one who complained of its raging a minute after the operation. It has ſeldom failed to cure *rigidities* or a *waſting of the muſcles*, and *hyſterical* diſorders, particularly if they be attended with *coldneſs in the feet*. He alſo ſays it has been of excellent uſe in bringing to a ſuppuration, or in diſperſing without ſuppuration, obſtinate ſwellings of various kinds, even thoſe that were ſcrophulous. In the rheumatiſm he ſays it has failed; but ſeldom in the caſe of young perſons, if they were taken in time.

THE manner in which electricity operated in theſe cures, Mr. LOVETT imagined to be, by removing ſecret obſtructions; which are probably the cauſe of thoſe diſorders. In all his practice he never knew an inſtance of harm being done by it, and thinks that, in all the caſes in which it has done any harm, the manner of adminiſtering it has been injudicious; and in general, ſuppoſes that the ſhocks have been made too great.

THE Rev. Mr. JOHN WESLEY has followed Mr. LOVETT in the ſame uſeful courſe of medical electricity; and recommends the uſe of it to his numerous followers, and to all people. Happy it is, when an aſcendency over the minds of men is employed to purpoſes favourable to the increaſe of knowledge, and to the beſt intereſts of mankind. Mr. WESLEY's account of cures performed by electricity agrees very well with that of Mr. LOVETT, whom he often quotes. He likewiſe directs nearly the ſame method of adminiſtration.

THIS account of the medical uſe of electricity by Mr. LOVETT and Mr. WESLEY is certainly liable to an objection, which will always lie againſt the accounts of thoſe perſons who, not being of the faculty, cannot be ſuppoſed capable of diſtinguiſhing with accuracy, either the nature of the diſorders, or the conſequences of a ſeeming cure. But, on the other hand, this very circumſtance of their ignorance of the nature of diſorders, and conſequently of the beſt method of applying electricity to them, ſupplies the ſtrongeſt argument in favour of its innocence, at leaſt. If in ſuch unſkilful hands it produced ſo much good, and ſo little harm; how much more good, and how much leſs harm would it poſſibly have produced in more ſkilful hands.

BUT whatever weight there be in this objection againſt the laſt mentioned writers, it certainly cannot be urged againſt ANTONIUS DE HAEN, one of the moſt eminent phyſicians of the preſent age; who, after ſix years uninterrupted uſe of it, reckons it among the moſt valuable aſſiſtances of the medical art; and expreſsly ſays, that though it has often been apply'd in vain, it has often afforded relief where no other application would have been effectual. But I ſhall recite in a ſummary manner from his *Ratio Medendi*, the reſult of all his obſervations on this ſubject.

WITH reſpect to partial *palſies*, in particular, he ſays, it never did the leaſt harm; that one or two perſons who had received no benefit from it in ſix intire months, were yet much relieved by perſevering in the uſe of it. That ſome perſons diſcontinuing it, after having received ſome benefit, relapſed again; but afterwards, by recurring to the uſe of electricity, recovered, though more ſlowly than before. Some perſons, he ſays, were relieved who had been paralytic one, three, ſix, nine, and twelve years, and ſome longer; but that in one or two of theſe caſes, the patients had received leſs relief, and more ſlowly than was uſual in recent caſes. In ſome caſes, he ſays, a moſt unexpected benefit had been found by thoſe who had been paralytic in their tongues, eyes, fingers, and other particular limbs. A *paralyſis* and trembling of the limbs, from whatever cauſe it aroſe, never failed to be relieved by it; and he relates one inſtance of a perfect cure being performed in a remarkable caſe of this nature, after receiving ten ſhocks.

DR. HAEN's cuſtom was to apply the operation for half an hour together at leaſt. He ſeems to have uſed gentle ſhocks; and he joined to electricity, the uſe of other remedies, which, however, would not have been effectual without it.

ST. VITUS's DANCE, he ſays, never failed to be cured by electricity. He always obſerved it to promote a more copious diſcharge of the menſes, and to relieve in caſes of obſtruction; but, for this reaſon, he adviſes that it be not adminiſtered to women with child. He found it of uſe in ſome caſes of *deafneſs*; but it entirely failed in its application to a *gutta ſerena*, and to a *ſtrumous neck*. Laſtly he relates a remarkable caſe, communicated to him by Mr. VELSE at the *Hague*, of the cure of a *mucous apoplexy*.

To thoſe caſes wherein harm may be apprehended from electrification, may perhaps be added the venereal diſeaſe, in which Mr. VERATTI adviſes, that electricity be by all means avoided.

I SHALL conclude this account of medical electricity with obſerving that there are two general effects of electricity on the human body, of which it ſhould ſeem, that phyſicians might greatly avail themſelves: Theſe are, that it promotes inſenſible perſpiration, and glandular ſecretion. The former is effected by ſimple electrification; and the latter by taking ſparks from the glands, or the parts contiguous to them; on which it acts like a ſtimulus. Of the former, inſtances have been given in the experiments of the Abbe NOLLET, and a few have been given occaſionally of the latter.

To theſe I ſhall now add, that LINNÆUS obſerved, that when electric ſparks have been drawn from the ear, it has inſtantly promoted a more copious ſecretion of ear-wax; and that it has alſo been obſerved, that, when the eye, or the parts about the eye, have been electrified, the tears have flowed copiouſly. But the moſt remarkable caſe that I have met with, is, of its promoting the ſecretion of that matter which forms the hair; whereby hair has been actually reſtored to a part that had long been bald.

HITHERTO electricity has been generally apply'd to the human body either in the method of drawing ſparks, as it is called, or giving ſhocks. But theſe operations are both violent; and though the ſtrong concuſſion may ſuit ſome caſes, it may be of diſſervice in others, where a moderate ſimple electrification might have been of ſervice.

THE great objection to this method is the tediouſneſs and expence of the application. But an electrical machine might be contrived to go by wind or water, and a convenient room might be annexed to it; in which a floor might be raiſed upon electrics, and a perſon might ſit down, read, ſleep, or walk about during the electrification. It were to be wiſhed, that ſome phyſician of underſtanding and ſpirit would provide himſelf with ſuch a machine and room. No harm could poſſibly be apprehended from electricity, apply'd in this gentle and inſenſible manner, and good effects are, at leaſt poſſible, if not highly probable. It would certainly be more for the honour of the faculty, that the practice ſhould be introduced in this manner, than that it be left to ſome rich valetudinarian, who may take it into his head, that ſuch an operation may be of ſervice to him.

SECT. V.

Dr. PRIESTLEY'S *Experiments on* ANIMALS.

AS I have conſtructed an Electrical Battery of conſiderable greater force than any other that I have yet heard of, and as I have ſometimes expoſed Animals to the ſhock of it, and have particularly attended to ſeveral circumſtances, which have been overlooked, or miſrepreſented by others; it may not be improper to relate a few of the caſes, in which the facts were, in any reſpect, new, or worth notice.

JUNE the 4th. I killed a Rat with the diſcharge of two jars, each containing three ſquare feet of coated glaſs. The animal died immediately, after being univerſally convulſed, at the inſtant of the ſtroke. After ſome time, it was carefully diſſected; but there was no internal injury perceived, particularly no extravaſation, either in the abdomen, thorax, or brain.

JUNE the 19th. I killed a pretty large Kitten with the diſcharge of a battery of thirty three ſquare feet; but no other effect was obſerved, except that a red ſpot was found on the pericranium, where the fire entered. I endeavoured to bring it to life, by diſtending the lungs, blowing with a quill into the trachea, but to no purpoſe. The heart beat a ſmall time after the ſtroke, but reſpiration ceaſed immediately.

June the 21ſt. I killed a ſmall Shrew with the diſcharge of a battery of thirty ſix ſquare feet, but no other effect was perceived, except that the hair of the forehead was ſinged, and in part torn off. There was no extravaſation any where, though the animal was ſo ſmall, and the force with which it was killed ſo great. This fact, and many others of a ſimilar nature, make me ſuſpect ſome miſtake, in caſes where larger animals are ſaid to have had all their blood veſſels burſt by a much inferior force.

In all the accounts that I have met with of animals killed by the electric ſhock, the victims were either ſmall quadrupeds, or fowls; and they are all repreſented as killed ſo ſuddenly, that it could not be ſeen how they were affected previous to their expiration. In ſome of my experiments, the great force of my battery has afforded me a pretty fair opportunity of obſerving in what manner the animal ſyſtem is affected by the electric ſhock, the animals which I have expoſed to it being pretty large; ſo that a better judgment may be formed of their ſenſations, and conſequently of the immediate cauſe of their death, by external ſigns. I do not pretend to draw any concluſion myſelf from the following facts: I have only noted them as carefully as I could for the uſe of phyſicians and anatomiſts.

June the 26th. I diſcharged a battery of thirty eight ſquare feet of coated glaſs, through the head, and out at the tail of a full grown Cat, three or four years old. At that inſtant, ſhe was violently convulſed all over. After a ſhort reſpite, there came on ſmaller convulſions, in various muſcles, particularly on the ſides; which terminated in a violent convulſive reſpiration, attended with a rattling in the throat. This continued five minutes, without any motion that could be called breathing, but was ſucceeded by an exceeding quick reſpiration, which continued near half an hour. Towards the end of this time, ſhe was able to move her head, and fore feet, ſo as to puſh herſelf backwards on the floor; but ſhe was not able to move her hind feet in the leaſt, notwithſtanding the ſhock had not paſſed through them. While ſhe continued in this condition, I gave her a ſecond ſtroke, which was attended, as before, with the violent convulſion, the ſhort reſpite, and the convulſive reſpiration; in which, after continuing about a minute, ſhe died.

Being willing to try, for once, the effect of a much greater ſhock than that which killed the cat, upon a large animal, I gave an exploſion of ſixty two ſquare feet of coated glaſs to a dog of the ſize of a common cur. The moment he was ſtruck, which was on the head (but, not having a very good light, I could not tell exactly where) all his limbs were extended, he fell backwards, and lay without any motion, or ſign of life, for about a minute. Then followed convulſions, but not very violent, in all his limbs; and after that a convulſive reſpiration, attended with a ſmall rattling in the throat. In about four minutes from the time he was ſtruck, he was able to move, though he did not offer to walk till about half an hour after; in all which time, he kept diſcharging a great quantity of ſaliva; and there was alſo a great flux of rheum from his eyes, on which he kept putting his feet; though in other reſpects he lay perfectly liſtleſs. He never opened his eyes all the evening in which he was ſtruck, and the next morning he appeared to be quite blind, though ſeemingly well in every other reſpect.

Having diſpatched the dog, by ſhooting him through the hinder part of his head, I examined one of his eyes (both of which had an uniform bluiſh caſt, like a film over the pupil) and found all the three humours perfectly tranſparent, and, as far as could be judged, in their right ſtate; but the *cornea* was throughout white and opaque, like a bit of griſtle, and remarkably thick.

Before this experiment, I had imagined, that animals ſtruck blind by lightning had probably a *gutta ſerena*, on account of the concuſſion which is ſeemingly given to the nervous ſyſtem by the electric ſhock; whereas this caſe was evidently an inflammation, occaſioned by the exploſion being made ſo near the eyes, terminating in a ſpecies of the *albugo*; but which I ſuppoſe would have been incurable. One of the eyes of this dog was affected a little more than the other; owing, probably, to the ſtroke being made a little nearer to one eye than the other. I intended to give the ſtroke about an inch above the eyes.

In order to aſcertain the effects of electricity on an animal body, I, after this, began a courſe of experiments on the conducting power of its conſtituent parts; and for ſome time imagined that a piece of ſpinal marrow of an Ox conducted ſenſible worſe than the muſcular fleſh; but after a great number of trials with pieces of ſpinal marrow from various animals, and pieces of muſcular fleſh, of the ſame ſize and form, and in various ſtates of moiſture and dryneſs, I gave up that opinion as fallacious, but I cannot help wiſhing the experiments were reſumed with ſome more accurate meaſure of conducting power than hath yet been contrived.

Being willing to obſerve, if poſſible, the immediate effect of the electric ſhock on the heart and lungs of animals, I gave June the 5th, a ſhock from ſix ſquare feet to a Frog, in which the thorax had been previouſly laid open, ſo that the pulſation of the heart might be ſeen. Upon receiving the ſtroke, the lungs were inſtantly inflated; and, together with the other contents of the thorax, thrown quite out of the body. The heart, however, continued to beat, though very languidly, and there was no other ſign of life for about ten minutes. After that, a motion was firſt perceived under its jaws; which was propagated, by degrees, to the muſcles of the ſides; and at laſt the creature ſeemed as if it would have come to life, if it had not been ſo mangled. The ſtroke entered the head, and went out at the hind feet.

JUNE the 6th. I diſcharged a battery of thirty three ſquare feet through the head and whole extended body of another frog. Immediately upon receiving the ſtroke, there was, as it were, a momentary diſtenſion of all the muſcles of the body, and it remained ſhrivelled up in a moſt ſurpriſing manner. For about five minutes there appeared no ſign of life, and the pulſation of the heart could not be felt with the finger. But afterwards, there firſt appeared a motion under the jaws, then all along the ſides, attended with convulſive motions of the other parts, and in about an hour, it became to all appearance, as well as ever.

THE ſame day, I gave the ſame ſtroke to two other frogs. They were affected in the ſame manner, and perfectly recovered in leſs than three hours. Theſe facts ſurpriſed me very much. I attribute the recovery of the frogs partly to the moiſture, which always ſeems to cover their body, and which might tranſmit a good part of the ſhock; and partly to that proviſion in their conſtitution, whereby they can ſubſiſt a long time without breathing. To aſcertain this, I would have given the ſhock to toads, ſerpents, fiſhes, &c. and various other exanguious animals, but I had not an opportunity. Beſides, *it is paying dear for Philoſophical Diſcoveries, to purchaſe them at the expence of* HUMANITY.

THUS far Dr. PRIESTLEY—and I could heartily wiſh that the many uſeful hints and obſervations which are to be found in his work, were attended to by every electrician, till ſome of the important diſcoveries, to which they ſeem to lead, are fortunately obtained, and the track purſued till the ſcience be thoroughly explored.

AN

ESSAY

On ELECTRICITY, &c.

PART III.

Miſcellaneous EXPERIMENTS *and* OBSERVATIONS.

FEW or none of the refinements of ſcience afford ſo agreeable relaxation to the ſerious and liberal mind as Philoſophical experiments. The rational entertainment, and pleaſing inſtruction conveyed by ſuch enquiries, are conſtantly found to extend the faculties of the ſoul with an exalted idea of the beauty and ſublimity of nature, while they are almoſt irreſiſtibly led on to contemplate and adore its divine Source.

FEW other departments of ſcience yield ſo pleaſing, ſo various, and, at the ſame time, ſo aſtoniſhing phenomena, as that of electricity. The variety of appearances produced by an electrical machine, in a copious current of the fluid, are, indeed, ſometimes ſo ſtrikingly curious, that the mind ſeems to be, in a manner, ſuſpended between admiration of the *effects*, and enquiry into the *cauſe*. This affection ſeems to be natural and rational. The human mind can neither ceaſe to admire, nor remain ſatisfied with vague appearances: The ſuperior objects of its deſire are knowledge and certainty; in the purſuit of which its induſtry is chearfully exerted, and frequently rewarded with ſucceſs.

HENCE many electricians have patiently repeated and varied their experiments, till they have at length hit upon ſomething or other which has appeared ſatiſfactory and concluſive. Others, if they have not been quite ſo fortunate at demonſtration, have yet opened the way to farther enquiries, as well as greatly contributed to our amuſement, by inventing an agreeable variety of experiments, which, at the ſame time that they are entertaining, are not without their utility, having a general tendency to illuſtrate the theory of electricity, and to promote farther diſcoveries in the ſcience.

I SHALL therefore add a few other experiments to thoſe which have been already recited, chiefly for the ſake of leading thoſe who have been but little converſant with the ſubject, to an acquaintance with a variety of electric appearances, which conſtantly tend to facilitate a farther enquiry.———But few, indeed, of the following can be called *new* experiments, the greater part of them having been frequently repeated, but the apparatus, and the method of conducting many of them are conſiderably varied.

IT has been before obſerved, that all electrical appearances depend on the balance of the fluid being more or leſs diſturbed, and that none of thoſe appearances could ever be exhibited unleſs ſome bodies were made to contain either *leſs* or *more* than their *natural quantity*. In order to demonſtrate this fact the more eaſily, and for a great variety of other purpoſes, it is neceſſary that the cuſhion or rubber of the machine be as perfectly inſulated as poſſible, and that a conductor be connected with it (which may be called the *negative*) of the ſame kind and dimenſions as the *poſitive* or prime conductor. Theſe two conductors, by means of four moveable glaſs ſtands, may be placed in any direction that is required; either parallel to each other, obliquely, or at right angles.

If one end of a wire or chain be made to touch the *negative* conductor, while the other end touches the table, the electric matter will be accumulated as much as is poſſible on the *poſitive* conductor, and a ſtrong ſpark may be *taken from* it. If the chain be taken away from the negative, and hung to the poſitive conductor, upon turning the machine, the negative will be found to have as great a *deficiency* of the fluid as, in the former caſe, the poſitive had a *redundancy*, and as ſtrong a ſpark may be *given to* it: In this caſe, the electric matter is conveyed, by the friction of the glaſs, from the rubber and negative conductor, through the pointed wires, to the poſitive conductor, and from thence, through the chain, to the earth; by which means the negative is deprived of its natural quantity, and becomes in a ſituation ready to *receive a ſupply* from any body that approaches it. But, when the chain was hung to the negative conductor, the rubber had a conſtant ſupply of the matter from the earth, through that conductor and chain; the fluid was, by the motion of the glaſs, forced upon the poſitive conductor, whereby this became in a ſituation ready to *throw off* its redundant quantity.

Let one end of the chain be hung to the poſitive, and the other end to the negative, in which caſe the whole will be inſulated, and no ſupply of matter can be received from the ground; yet there will ſtill be a circulation of the natural quantity contained in the conductors and rubber. The glaſs cylinder, by its motion, conveys the fluid from the rubber to the conductors (which may now be conſidered as only one, from their being connected by the chain) and from theſe the rubber is again immediately ſupply'd. This is eaſily proved by taking the chain entirely away, and placing the ends of the conductors about an inch diſtant from each other; upon turning the machine, ſtrong ſparks will be ſeen to iſſue from the poſitive to the negative conductor. This can be no other than the fluid naturally belonging to the conductors, for, being both inſulated, no part of it can be received from the earth.

IN like manner, a pane of coated glaſs, a phial, or as many phials as we pleaſe, may be *charged* without having any connection with the earth or other non-electric. If the outward coating of a phial be made to reſt on either of the conductors, and the wire or hook which communicates with the inſide, be placed on the other, upon turning the machine the phial will become charged the ſame, or rather ſooner, than it does when the coating is in contact with the earth, though none of the matter, with it is ſaid to be charged, comes from thence; nor are the conductors themſelves robbed of the ſmalleſt quantity of their fluid. Hence it is evident that the glaſs, after it is charged, contains no greater *quantity* of the electric matter than it did before, or than what is at all times natural to it, the fluid being only conveyed from one ſide to the other. If a charged phial be placed on glaſs, or ſuſpended by ſilk, it may be made to explode with a diſcharging rod held by a glaſs handle; whereby it appears that the contents of the phial have no tendency to eſcape into the earth.

A PHIAL may alſo be diſcharged in the following manner, which makes an appearance extremely curious in the dark—let the phial be fully charged, and placed on a ſmall glaſs ſtand under the recipient of an air-pump; as the recipient is exhauſted the electric fire will iſſue from the wire of the phial in a very luminous pencil of rays, and continue flaſhing to the coating till all the air be pumped out, when the phial will be found totally diſcharged. From this it appears that a *vacuum*, or a ſpace nearly void of air, not only admits of a rapid paſſage of the electric fluid, but cauſes it to aſſume the moſt lucid appearance.——If the phial be *negatively* charged, the current of fire will appear to have a contrary direction to that which it had before.

As the force of an electric charge is not lodged in the metallic coating of the glaſs, the glaſs may be diveſted of its coating and yet remain charged.—Take a pane of thin window glaſs, eight or ten inches ſquare, and let a piece of thin ſheet lead be placed on each ſide of it, not nearer to the edges of the glaſs than about two inches: This being placed on the palm of the hand, may be charged by bringing the upper lead to the conductor; when it is charged, the glaſs may be taken hold of by the edges or corners, and the leads thrown off; the glaſs will ſtill retain its charge, even though it be wiped on both ſides with a dry handkerchief. To try this, let the plates of lead be cautiouſly replaced on the glaſs (it matters not whether the ſame lead be put on that ſide of the glaſs it was on before, or the other; or whether it be firſt placed on the *poſitive* or *negative* ſide of the glaſs.) On forming a communication, by bringing a finger of one hand to the upper ſide of the glaſs, while the lower ſide touches the other hand, it will be found that the glaſs had loſt but little of its force by having the leads taken off.

The glaſs may, indeed, be charged without uſing the leads, if it be laid on the palm of the hand, and the upper ſide of the glaſs be brought to a ſmall chain hanging from the conductor, and moved ſo that the chain may touch the ſurface in every part of the glaſs that is oppoſite to the hand: By this means it will acquire a conſiderable charge; which may be known either by placing on the leads as before, or by applying the palm of the other hand to the upper ſide of the glaſs.

THE glaſs, however, cannot be charged, that is, it cannot be made to acquire a redundancy of the electric matter on one ſide, and a deficiency on the other, without the aſſiſtance of ſome conducting ſubſtance. If one ſide of a pane of glaſs, thoroughly dry, be apply'd to the prime conductor, without any conducting ſubſtance in contact with the other, it will be found that both ſides of the glaſs are electrified alike,—both *poſitively*;—and, if apply'd to a conductor negatively electrified, each ſide will have a *deficiency* of its natural quantity; but in either caſe the electricity will be but weak.

THE *force*, then, ſo remarkably great in an electric *exploſion*, appears to be produced by the violent attraction of what may be called an electric *vacuum* and *plenum*; and the force of this attraction ſeems dependant on ſeveral concurrent circumſtances—the impermeability of the electric body between the two powers—the perfection of the conductors in contact with the electric—the proximity of the *plus* and *minus* electricity—and the degree in which the fluid is compreſſed.

As the fluid could never be compreſſed or accumulated in any degree, unleſs ſome bodies *reſiſted its paſſage*, it follows, that the more capable any body is of ſuch reſiſtance, the more ſtrongly may the fluid be compreſſed, before its force becomes ſufficient to *penetrate* that body.———If the conducting ſubſtances, with which the electric is connected, are not ſufficiently perfect to admit of a free paſſage of the fluid, a part only of the fluid will be tranſmitted through them at the inſtant of the exploſion, and the equilibrium will not be completely reſtored.—The nearer the approach of the *plus* and *minus* electricity to each other, the more will their attractive force be exerted, and the greater their efforts to reſtore the balance; perhaps, if it could be nicely determined, the ratio of the attractive power would be found to be as the ſquare of its diſtance.

When the charge of an electric ſubſtance is arrived to a certain heighth, that ſubſtance will be *penetrated* by the fluid, if it be thin enough to permit the power of the charge to overcome the reſiſtance of the electric, or come within what may be called its *ſtriking diſtance.* In this caſe many electric ſubſtances will be perforated by the paſſage of the fluid; others, leſs perfect in their kind, will ſuffer the charge to paſs through them without rending.——A pane of glaſs, the 20th part of an inch thick, ſtrongly charged, by means of tinfoil or ſheet lead, will frequently be perforated with ſeveral holes, and the glaſs round the holes be pulverized to a ſurpriſing minuteneſs.——A plate of ſealing-wax, of the ſame thickneſs, will alſo generally be perforatted, and ſometimes broken to pieces.—Baked wood will often be rent, but will more frequently permit the fluid to paſs through its pores in a very fine and acute ſtream.

The *air*, as an electric, we well know, reſiſts the paſſage of the fluid; otherwiſe we never could be acquainted with any electrical appearances. The air ſurrounding an electrified non-electric is always, in ſome meaſure, *charged* with the fluid; for, if any other non-electric approaches that which is electrified, the ſurface preſented towards the electrified body is always found to be poſſeſſed of a contrary electricity. But, that a *plate of air* may be charged in the ſame manner as other electric ſubſtances, may be rendered evident by ſuch an apparatus as the following, which I have found to be extremely convenient for many other experiments. As the ſubject is curious, and ſeems to lead to farther diſcoveries of the nature of the electric fluid, I ſhall be ſomewhat particular in the uſes that may be made of it, hoping others, who have more leiſure than myſelf to purſue the enquiry, may be able to improve and apply it to more material purpoſes.

Let two boards be made of inch deal, of an equal ſize, and circular form, each containing about 8 or 9 ſquare feet of ſurface. It is neceſſary that they ſhould be perfectly plain and level, and planed quite ſmooth. Let one ſide of both of them be nicely covered with tinfoil, ſmoothly paſted on, and turned over the edges; the other ſide of one of the boards, covered in like manner with gilt leather. The board with only the tinfoil on it, is to be inſulated upon glaſs ſupporters, and placed on a table, ſome feet diſtant from the electrical machine: The other board ſuſpended directly over it, by a pully, from the ceiling of the room; this is likewiſe to be inſulated, by means of a ſilken ſtring, and, by the pully, may be adjuſted to any required diſtance from the other board.

In order to electrify the air, let that ſide of the ſuſpended board which has the gilt leather on it be uppermoſt, and the tin-foil'd ſurfaces of each board exactly parallel to each other, at the diſtance of about one inch. The upper board is then to be made a part of the prime conductor, by being connected with it by means of a chain or wire; the under board, at the ſame time, connected with the earth, by ſuſpending a chain to a ſmall hook or ring on the lower ſide, the end of which chain may hang down to the floor; the ring to which the chain is ſuſpended, ſhould have an immediate communication with the tinfoil on the other ſide of the board, by means of a ſmall ſtrip of the metal paſted over the edge of the board.

When the upper board is ſtrongly electrified, the fluid will be repelled from the under one, and driven through the chain into the earth, by which means this board becomes electrified *negatively*. The *ſpace*, or, as it may be termed, the *plate of air* between the two boards, acts as a plate of *glaſs* or other electric, forming a kind of barrier, which, by its reſiſtance of the fluid's paſſage, keeps aſunder the *plus* electricity from the *minus*. In this ſituation, let a perſon take hold of the chain which hangs from the under board, and at the ſame time bring his other hand to the upper board, and he will immediately receive the ſame kind of ſenſation or ſhock as from a charged phial, and be ſenſible that the fluid has paſſed entirely through him.

In this caſe it is not to be expected that the ſhock or exploſion will be proportionably ſtrong to the quantity of ſurface contained on the boards. If the boards are one inch diſtant from each other, and if the proportion of attraction before hinted at be admitted, it follows, that the charge will be but about one hundredth part as ſtrong as when the two electric powers are ſeparated by a plate of glaſs one tenth of an inch thick—The quantity of fluid compreſſed; the degree of compreſſion, and the portion of time neceſſary to *charge* the apparatus, will likewiſe be in the ſame proportion.

I don't know that the air can be made to receive a ſtronger charge than this; for, if the boards are placed cloſer to each other than one inch, they will generally explode before they are fully charged; and ſometimes the ſtriking diſtance will be much farther, if there be any roughneſs or irregularity near the edges. When they explode, the electric matter will be ſeen to dart from the upper board to the under, reſtoring the equilibrium in the diſcharge of a very ſtrong ſpark, attended with a loud report.

That a part of the natural quantity of the fluid belonging to the under board is actually repelled, and driven off through the chain to the earth, may be rendered very evident; for, when the apparatus is charged, if the chain be taken away from the under board, and the upper one drawn up by the pully to ſome diſtance, the former will be found to be negatively electrified; — and, if the end of the chain, inſtead of touching the floor, be made to communicate with the wire of a coated phial, the phial will by this means be pretty ſtrongly charged.

⁂ THESE, and ſeveral of the following experiments will generally ſucceed better, when the chain from the under board (inſtead of hanging on the floor) is connected with the inſulated rubber of the machine.

A Method of producing ARTIFICIAL LIGHTNING.

THE ſimilarity of electricity and lightning had been frequently remarked, before the ingenious and concluſive experiments of Dr. FRANKLIN and a few other gentlemen, demonſtrated that theſe phenomena ariſe from the ſame cauſe. At this time the opinion is almoſt generally received, that lightning and thunder are no other than the effects of an accumulation and diſcharge of the electric fluid. Some clouds are found to be replete with this fluid, or, electrified *poſitively*; others to have a deficiency, or a *negative* ſtate, with reſpect to the fluid. The different and remarkable effects of theſe clouds have been accurately obſerved—the one has conveyed a *plus*, the other a *minus* electricity, to an apparatus erected for the purpoſe of receiving their influence.

IF two ſuch clouds, in oppoſite ſtates, approach within the ſtriking diſtance of each other, the one violently diſcharges its redundant matter to the other, which, from its deficiency, as violently receives it. When a large cloud, ſtrongly impregnated with electricity,

tricity, deſcends near the earth, it generally diſcharges a quantity of it on the firſt eminence or building that it approaches; and the tremendous effects it has ſometimes produced in its paſſage, are but too well known.

THESE effects will be the ſame, whether the cloud be in a poſitive or negative ſtate. If it be the latter, the fluid ſtrikes from the earth to the cloud: But in either caſe, the cloud probably cauſes whatever it ſtrikes to be in an oppoſite ſtate, before the exploſion.

THE light and ſound accompanying theſe phenomena are, indeed, ſo awfully ſublime, that we cannot well reflect on the *weakneſs of humanity* when, in the ages of ſuperſtition, they were ſuppoſed to be the immediate miniſters of vengeance ſent from an *inraged* DEITY;—they are now more rationally conſidered as the natural means of reſtoring a neceſſary *equilibrium*—the rough diſcords of nature, productive of general harmony.

BUT theſe great and alarming appearances may be very innocently and agreeably imitated in miniature, by means of the two plated boards before-mentioned.—Let the upper board, which is ſuſpended from the ceiling by ſilk, be turned the contrary ſide downward to what was before directed, viz. let the ſide which has the gilt leather on it face the lower board, at the diſtance of an inch and a half. On the ſurface of the lower board may be placed one or two ſmall metal hemiſpheres—theſe may ſerve to repreſent hills or eminences; the board itſelf, a ſpacious plain; and the upper one, a large electrified cloud;—let this board be connected to the prime conductor of the machine, and the lower one to the rubber. The apparatus thus diſpoſed, upon turning the machine (if it acts vigorouſly, which is always ſuppoſed in theſe experiments) the upper board will be ſeen to diſcharge all the force of its contents on one of the metal hemiſpheres, in a ſtrong flaſh, attended with a ſmart exploſion; at the ſame time, the gilt ſurface of the upper board will exhibit a moſt beautiful appearance; vivid corruſcations of electric light will be ſeen to dart over it in various directions, with an exact reſemblance of lightning. This, indeed, is more than an *imitation*—it is nature inveſted with her own attire.

In order to repreſent a cloud *negatively* electrified, let the lower board be connected to the prime conductor, and the upper one to the rubber; the appearances will be nearly the ſame, but the experiment generally ſucceeds better this way than the other.—If a ſmall coated phial be made uſe of in this experiment, and connected with the apparatus ſo that it may explode with the boards, the flaſhes of light will extend ſtill farther, and the exploſions be more loud.

The effects of lightning on buildings, &c. together with a method of preſerving them, are agreeably ſhewn by a ſmall appendage called a *Thunder-Houſe*, reſembling the ſide of a houſe or pile of building. A braſs wire is let into it from the top to the bottom, but ſo contrived, that the connection may be occaſionally broken in the middle part of it, by inverting a ſmall piece of wood wherein part of the wire is inſerted. This may be uſed ſeparately, or with the boards, in the lightning experiment. When the diſcharge is made, the piece of wood will be blown out to a conſiderable diſtance by the lateral force of the exploſion, when the connection is broken; but if the wood be placed ſo as to render the connection of the wire complete, the electric matter will paſs through it, and the wood remain undiſturbed by the exploſion.

On the top of the wire (which repreſents the *conducting-rod* of a building) a ſmall braſs ball is generally fixed, and another on the end of a wire communicating with the prime conductor and inſide of the phial: Between theſe two balls the exploſion is received, ed, when the charge has acquired a ſufficient degree of ſtrength; but if one of the balls be taken off, and the point of the wire expoſed to the other ball, no exploſion can be produced, the point drawing off the electric matter in a ſmall ſtream. And it is obſervable, that, in the foregoing experiment, if a fine pointed wire be made to project a little way from one of the metal hemiſpheres, the boards cannot in any degree be charged, the wire receiving all the fluid from the upper board as faſt as the machine can produce it. A large jar, or even a battery may be almoſt inſtantly diſcharged without any exploſion, by bringing the point of a needle near the wire of it; ſo powerful an effect have points in receiving and throwing off the electric matter.

It was from obſervations of this kind that Dr. Franklin ſuppoſed it to be very practicable to draw the electric matter from the clouds during a thunder ſtorm, by means of pointed iron rods projected from the tops of buildings, &c. and, on the trial, finding it to anſwer his expectations, he very juſtly concluded, that theſe iron rods or conductors, might be ſucceſsfully uſed as means of ſecuring ſuch buildings as were much expoſed to lightning, from its dreadful effects. The conductors were accordingly erected, and the buildings really ſecured.[x]

The Doctor alſo obſerved, that thoſe buildings which are covered with lead, and have leaden ſpouts continued from the roof into the ground to carry off the water, are never hurt by lightning, as whenever it falls on ſuch a building, it paſſes in the metals, and not in the walls.

He adds ‘ When other buildings happen to be within the ſtriking diſtance from ſuch clouds, the fluid ‘ paſſes in the walls, whether of wood, brick or ſtone,

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[x] See Franklin's Letters.

‘ quitting the walls only when it can find better con-‘ ductors near them, as metal rods, bolts, and hinges ‘ of windows or doors, gilding on wainſcot, or frames ‘ of pictures; the ſilvering on the backs of looking-‘ glaſſes; the wires for bells; and the bodies of ani-‘ mals, as containing watry fluids. And in paſſing ‘ through the houſe it follows the direction of theſe ‘ conductors, taking as many in its way as can aſſiſt it ‘ in its paſſage, whether in a ſtrait or crooked line, ‘ leaping from one to the other, if not far diſtant from ‘ each other, only rending the wall in the ſpaces where ‘ theſe partial good conductors are too diſtant from each ‘ other.

‘ An iron rod being placed on the outſide of a ‘ building, from the higheſt part continued down in-‘ to the moiſt earth, in any direction, ſtrait or crooked, ‘ following the form of the roof or other parts of the ‘ building, will receive the lightning at its upper end, ‘ attracting it ſo as to prevent its ſtriking any other part; ‘ and affording it a good conveyance into the earth, ‘ will prevent its damaging any part of the building.— ‘ If the building be very large and extenſive, two or ‘ more rods may be placed at different parts, for greater ‘ ſecurity.

‘ A person apprehenſive of danger from lightning, ‘ happening during the time of thunder to be in a houſe ‘ not ſo ſecured, will do well to avoid ſitting near the ‘ chimney, near a looking-glaſs, or any gilt pictures ‘ or wainſcot; the ſafeſt place is in the middle of the ‘ room, (ſo it be not under a metal luſtre ſuſpended by ‘ a chain) ſitting in one chair, and laying the feet up ‘ in another. It is ſtill ſafer to bring two or three ma-‘ traſſes or beds into the middle of the room, and fold-‘ ing them up double, place the chair upon them; for ‘ they not being ſo good conductors as the walls, the ‘ lightning will not chuſe an interrupted courſe through

‘ the air of the room and the bedding, when it can go
‘ through a continued better conductor the wall. But,
‘ where it can be had, a hammock or ſwinging bed, ſu-
‘ ſpended by ſilk cords equally diſtant from the walls on
‘ every ſide, and from the ceiling and floor above and
‘ below, affords the ſafeſt ſituation a perſon can have
‘ in any room whatever, and what indeed may be deem-
‘ ed quite free from danger of any ſtroke by lightning.’

But as very few people are ſufficiently provident to have at hand ſuch a ſwinging bed as above, I apprehend it will ſeldom or never be uſed; what would anſwer the purpoſe nearly as well, and which might always be ready for uſe, is one of the inſulated boards before mentioned; a perſon ſitting in a chair placed on ſuch a board in the middle of the room, need not be under any great apprehenſion from the effects of lightning.

It has been objected to the uſe of *pointed rods* for the purpoſe of ſecuring buildings, that they have too powerful a tendency in attracting the lightning to the building whereon they are fixed; that probably, in a violent thunder-ſtorm, a larger quantity may be received by means of ſuch points, than can be conveyed off by the conductor, unleſs it be very large, without ſome injury to the building; and that rods made *blunt* or round at the top would be better adapted to the purpoſe, as being leſs liable to *invite* the lightning, and, in caſe of an exploſion, altogether as ſafe, and ſufficient to conduct it off.

Dr. Franklin, however, appears to have been of a different opinion, and ſuppoſes that the pointed rods will not only *conduct* a ſtroke of lightning with ſafety to the building, but that they have alſo a probable tendency to *prevent* a ſtroke, and that this is one intention of their being made pointed: “ But, ſays he, to have
“ a better chance of obtaining this end, the points
“ ſhould

"ſhould not be too near to the top of the chimney, "or higheſt part of the building to which they are "fixed, but ſhould be extended five or ſix feet above "it; otherwiſe their operation in ſilently drawing off "the fire (from ſuch fragments of cloud as float in "the air between the great body of cloud and the "earth) will be prevented."[y]

IT muſt be owned that the circumſtance of *ſilently drawing off* a part of the electric matter from the clouds is a very deſireable one; and though the points may never abſolutely *prevent* a ſtroke, yet, if they are capable of effecting a *protraction* of it, by receiving, for the ſpace of a few ſeconds prior to the exploſion, a part of the fluid in the form of a *current*—this might probably be the means both of *directing a paſſage* for the fluid, and of *leſſening the force* of the ſtroke, which chiefly conſiſts in *the whole* being conveyed in an *inſtantaneous exploſion.*

THAT ſuch *points* have at leaſt a probable tendency to *leſſen* an exploſion by firſt receiving the fluid in a gradual manner, I apprehend will appear pretty evident (if the analogy between electrical experiments and the great operations of nature be allowed) from what was before obſerved on the diſcharging of large jars by means of points—a jar, or a conſiderable number of them, being charged, and a braſs ball fixed to the end of the chain that communicates with the outſide having a very fine pointed wire, about an inch long, projecting from it; if this point be brought near the prime conductor, a current of the fluid will iſſue from it to the point; as ſoon as the point is brought nearly to touch the conductor there will be an exploſion, but not a fourth part, perhaps, ſo forcible as it would have been without the point. If the point be held for three or four ſeconds within half an inch of the conductor, the jars will be diſcharged without any exploſion.

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[y] FRANKLIN's letters.

Besides, it ſeems probable that pointed rods erected ſome feet higher than the top of a building, may have a tendency to prevent the building itſelf from acquiring ſo great a degree of a contrary electricity to the cloud as it otherwiſe would, and on which the violence of the exploſion in ſome meaſure depends; for we may reaſonably ſuppoſe the atmoſphere between the cloud and the earth, before a ſtroke of lightning, to be in ſome degree *charged* with the electric fluid. If the cloud be in a *poſitive* ſtate, the eminence or building that it approaches, and perhaps a great extent of ground under it, will be *negative*; and the contrary if the cloud be negative.

That points have this effect of rendering the ſurface they are projected from leſs capable of acquiring a contrary electricity to that of the electrifying body, appears not only from the effect of a point projected from the ſurface of one of the boards, before mentioned in the lightning experiment, but from numberleſs others.—I conſider the *point* itſelf as always *poſitively* electrified, whether it be *receiving* or *throwing out* the fluid, and ſo far from being at any time in a *negative* ſtate, that, in either caſe, the fluid muſt be greatly condenſed there.

It ſeems then to be rather contrary to *electrical* appearances, to ſuppoſe that a *point*[z] is capable of producing an *exploſion* where there would have been none in the abſence of the point; for, by facilitating the entrance (or exit) of the fluid, it has an evident tendency to *leſſen*, and ſometimes totally *prevents* an exploſion, the force of which is apparently *increaſed* by the reſiſtance of large ſurfaces.

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[z] By *points* I would here be underſtood to mean wires terminating extremely acute, ſuch as the point of a fine needle; a rod of iron terminating in the ſize of a gooſe quill may, in ſome caſes, be termed a *point*, but ſuch a point as this will receive an electric exploſion at a greater diſtance than a metal ball of an inch diameter.

But, after all, it may be queſtioned whether any of our little experiments in electricity are ſufficiently analagous to the ſublime operations diſplayed in the heavens, to point out with any degree of certainty what will, or will not be the effects of theſe pointed rods during a thunder-ſtorm;—having no greater an elevation than a few feet above the top of a chimney, and being ſeldom more than a few inches in circumference, perhaps they can have but little effect in drawing off any conſiderable quantity of the electric matter from a thunder-cloud: Some of theſe clouds are of a ſtupendous magnitude; and ſuch a conductor ſeems to bear but a very inconſiderable proportion to a cloud of ten thouſand acres extent, fully charged with electric particles, as Dr. Franklin ſuppoſes ſome of them to be.—The rods, however, are generally found from experience to be ſtruck by ſuch parts of the cloud as approach near enough to them, and to convey to the earth the quantity of lightning they receive without injury to the building: And it has been known, that a conductor no larger than a curtain-rod, and even a bell-wire has conducted, with ſafety to the building, a ſtroke ſufficient to ſhatter every part of it that was not connected with conducting ſubſtances.

But, whether it may be thought moſt proper to have the conductors *elevated* and reduced to *a point* or otherwiſe, for greater ſecurity it will undoubtedly be adviſeable to make them of a ſize much larger than a common curtain rod, as we cannot ſay how great a quantity of the fluid may one time or other paſs through them. The largeſt conductors I have heard of are thoſe of St. Paul's Church, at London; which, in ſome places, are four inches broad and half an inch thick; not of the ſame form throughout, but varied conveniently to the form of the building. Notwithſtanding there were four of theſe large conductors, the ſtroke of lightning they received on the 22d of

March, 1772, (which at the ſame time ſtruck the Chapel in *Tottenham-court Road*) appears to have made one of them red hot.—The croſs on the top of that edifice being ſufficiently elevated, the conductors were not projected above it with any ſharp points;—but I don't find that the building was any way damaged by the lightning.

When conductors are not large enough to convey the quantity of fluid forced into them, and afford it a free paſſage to the earth, they will ſuffer ſo violent an agitation by the rapid current of the fluid, that they will either be rendered glowing hot and melted, or elſe conſumed and totally exploded: In either caſe, eſpecially the latter, that which is to be dreaded from its effects is the *lateral force* of the exploſion;—when the fluid is obſtructed in its paſſage by a conductor too ſmall, it burſts from it in any direction, to the next neareſt conductor, rending in its way whatever reſiſtance it meets with, that is, almoſt every thing but metals.

But, in the Experiments I have made with large jars and batteries, I never could obſerve that this lateral force was in any degree exerted except where an exploſion was produced: By an *exploſion* I here mean the paſſage of the fluid through the *air*, when the chains or wires that formed the communication were not in contact with each other—when the fluid has paſſed over the ſurface of any imperfect conductor without entering it—or when a wire has been melted and diſperſed by being too ſmall to conduct the fluid; in theſe caſes I always found the lateral force very conſiderable in every place where the fluid thus viſibly paſſed thro' the air. When the charge is ſtrong, and a ſmall ſteel wire forms a part of the circuit, it will be inſtantly exploded and diſperſed, and large glowing ſparks be driven from it with great violence, in all directions, to the

the diſtance of eight or ten feet. If bran or any light ſubſtances are laid near it, they will alſo be blown away; this will likewiſe generally be the caſe, when ſuch ſubſtances are laid near the place where the ends of two wires meet, or on a chain, the links of which are ſeldom in abſolute contact: But when the circuit was formed by one long wire, though a ſmall one, and the force of the charge very conſiderable, I never found the leaſt appearance of a lateral force; even feathers and the lighteſt ſubſtances that were laid on it, were not ſtirred by the exploſion.

A SMALL wire three inches in length will conduct a great force of electricity perfectly well; but if the ſame wire be no more than two inches, a much leſs force will entirely conſume it; and a wire that in *one piece* would have conducted the charge, if it be joined in the middle by a link, it will be melted and an exploſion produced in that place.

FROM hence I apprehend that conductors for the preſervation of buildings would beſt anſwer the purpoſe, if they were to be made of one continued rod or bar of iron; but where this cannot be done conveniently, it ſhould be contrived that the joinings be in places detached from the walls and other parts of the building, and the parts of the joints forced as cloſe as poſſible in contact; That the conductors, if they can conveniently, be at the outſide of the houſe, and either detached from it at ſome little diſtance, or fixed to the wall, not by iron cramps, but by wedges of wood, pitched ropes, or ſome other ſubſtance that is an imperfect conductor. Whether they be reduced to a perfect point at top or not, it ſeems neceſſary for ſeveral reaſons that they ſhould have ſome degree of elevation above the higheſt part of the building, and the lower end run ſeveral feet into the earth in a direction oblique from the foundation.

Of the AURORA BOREALIS, METEORS, *&c.*

SINCE electricity has become a material topic of philoſophical enquiry, it has thrown new light on a variety of intereſting ſubjects, and has been the means of elucidating the cauſe of many appearances in nature upon rational principles, which before was rendered more obſcure by deſultory conjecture. It ſeems to be the current opinion of thoſe who have conſidered the ſubject, that the *Aurora Borealis* is occaſioned by the flaſhings of the electric fluid from clouds poſitively electrified, to other diſtant ones that are either in a contrary ſtate, or leſs electrified, through a very rare medium of air, where there is little or no reſiſtance to its paſſage.

A VERY perfect repreſentation of this may be obtained by means of a double barometer-tube, bent in the middle ſo as to form a kind of an arch. This is to be filled with quickſilver, and each end of the tube inſerted into a ſmall baſon of the ſame fluid. When the tube is erected, the quickſilver will quit the upper part, and ſtand in each of the legs at the ſame heighth as in a common barometer, leaving a very perfect vacuum in the top of the arch. If this part of the tube be connected to the prime conductor of the electrical machine by means of a chain or wire, it will occaſion a beautiful appearance of the electric light *in vacuo*, with various flaſhings and vibrations like the northern lights. The wire of a ſmall charged phial apply'd to the upper part of the tube will produce the ſame effect; and, in dry weather, the flaſhes will continue for a conſiderable time after the phial is removed.

ANOTHER way of producing this appearance is with a ſingle glaſs tube, exhauſted of air and hermetically ſealed. If this tube be rubbed with a woollen cloth it will become luminous, but much more ſo if apply'd to any electrified body. When the tube is excited with a very vigorous electricity, particularly the negative, the corruſcations will be exceedingly vivid and brillant; and if the hand be apply'd to the end of it, a bright ſpark will ſometimes dart along the tube like a meteor in the air.

The Electrical WHIRLWIND *and* WATERSPOUT.

IT has been ſuppoſed by ſome ingenious men, that Waterſpouts, Whirlwinds, and even Earthquakes are likewiſe produced by the influence of the electric fluid, when formed into certain modifications with reſpect to the ſtate of the air, ſituation of the country, &c.[a]

To form ſome kind of repreſentation of the *waterſpout* by electricity, let the two boards be adjuſted in the manner before directed for electrifying a plate of air, but ſomewhat farther diſtant from each other. A ſmall glaſs cup nearly filled with water is to be placed on the under board, and a narrow ſtrip of tinfoil paſted over the edge of the cup, ſo that one end may touch the water, and the other the plated ſurface of the board. Directly over the middle of the cup of water, a ſmall braſs ball may be made to project from the upper board, about half an inch diſtant from the ſurface of the water, and the lower board connected with the inſulated rubber by a chain. When the machine is put in motion, the water will be ſeen to acquire a convex ſurface, riſing in the centre; ſmall particles of it will ſometimes fly from it to the ball, while the ball throws out a lucid ſtream to the water.

If the ball be made wet, ſo that a drop of water may hang from it, the drop will be formed into the ſhape of an inverted cone; and a cone of electric light (the baſe of which will be on the ſurface of the water in the glaſs cup) will be ſeen to iſſue from the cone of water; This will exhibit the curious appearance of a double cone, half water and half fire.

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[a] See PRIESTLEY's Hiſt. of Electricity.

THIS experiment may be performed in another manner, by placing the cup of water on the upper board, and bringing the end of a diſcharging rod (having a braſs ball to it) near the ſurface of the water: The appearances will be nearly the ſame as before, except that, in order to procure the double cone, the cup of water muſt be negatively electrified.

IN order to repreſent the appearance of a *whirlwind*, let the boards be placed in the manner before directed, but four or five inches apart; firſt placing a quantity of bran and very ſmall pieces of thin paper in the centre of the lower board. When the machine is ſet in motion the paper and bran will be agitated in a very amuſing manner, being attracted and repelled between the two boards with ſurpriſing rapidity. The chain from the under board may be taken off, and the board now and then touched with the hand, which gives a pleaſing variation to the motion of the bran. If the lower board be connected to the inſulated rubber, the motion will increaſe and be very rapid—when the chain is taken off it will not be ſo violent—if the upper board be touched the motion will be ſtill more languid, and if both boards are touched at the ſame time all motion of the bran will immediately ceaſe.

BUT the moſt ſurpriſing appearance in this experiment, and what gives it the moſt exact reſemblance of a whirlwind, is, that ſometimes, when the electricity is very ſtrong, a quantity of the paper and bran will accumulate in one place, forming a kind of column between the boards, and ſuddenly acquire a ſwift horizontal motion, moving like a whirling pillar to the edge of the boards, and from thence fly off and be ſcattered about the room to a conſiderable diſtance. I own I am entirely at a loſs to account for this extraordinary appearance—I call it extraordinary becauſe it but ſeldom occurs, and ſeems to depend either on a certain degree of attraction, quantity of the bran, or diſtance between the boards; and I could ſeldom get it to ſucceed perfectly but by accident.

The different Appearance of POSITIVE *and* NEGATIVE *Electricity.*

ONE of the firſt enquiries naturally made by thoſe who are unacquainted with electrical appearances, when they draw a ſpark from the prime conductor, is, Whether the fire proceeds from the conductor, or from the body that is made to approach it? The rapidity of motion in the ſpark frequently deceives the eye, and we may often fancy it proceeds from the one, while, in fact, it comes from the other. I have ſometimes been a little diverted with the contention of two perſons who have ſtood oppoſite to each other,—one has inſiſted that it came from the conductor, while the other was as poſitive that he ſaw it proceed from the diſcharging-rod: I have deſired them to change places with each other—they then both began to doubt of their former opinion; but were generally convinced by the following experiment.—Take a braſs rod about a foot long, through which are inſerted ten or a dozen ſmall wires; each end of the wires projecting from the rod about one inch, in oppoſite directions: Let the rod be inſulated on a glaſs ſtand, and the ends of the wires placed parallel to, and within an inch diſtance from the negative conductor.[b] In this caſe whenever the finger is apply'd to the top of the glaſs ſtand, fine ſtreams or pencils of electric light will be ſeen to iſſue from the ends of the wires to the conductor, while the remoter ends will be only illuminated with a ſmall ſtar or ſpeck of light.—If the rod of wires be removed from the negative, and placed at the ſame diſtance from the poſitive conductor, the appearance will be juſt contrary; the ſmall ſtars will be ſeen at the ends of the wires neareſt to the conductor, and the ſtreams iſſue from the other ends.

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[b] We ſtill ſuppoſe the negative conductor to be of the ſame form and ſize as the poſitive, or prime conductor.

THERE is alſo as remarkable a difference in the *ſpark* itſelf, when drawn at a conſiderable diſtance. To do this the electricity muſt be vigorous, the conductor very large and well inſulated: A braſs ball of about an inch diameter ſhould be made to project from the end of it. Sparks may then frequently be drawn from the ball at the diſtance of ſix, eight, or ten inches. Dr. PRIESTLEY lately informed me that he has, by this means, drawn ſparks more than thirteen inches in length. Theſe long ſparks have a very curious appearance: They never fly in ſtrait lines, but form various curves and odd directions in their paſſage. If taken from the *poſitive* conductor, they come out ſmall, and expand broad before they enter the diſcharging-rod; on the contrary, when they are drawn at the *negative* conductor, they appear large at the conductor and ſmall at the rod. A ſpark equally long may be drawn at the negative conductor as from the poſitive, if the rubber be properly inſulated; but with this difference; that they come off longeſt from the *end* of the poſitive to a *broad* ſurface, and from a *narrow* ſurface to the *middle* of the negative.

WE are not to ſuppoſe that the electric ſpark is actually *extended* in its paſſage to the ſame length and form as it appears to our ſight;—this is only a *deceptio viſus*, like that of a *circle of fire* produced by a firebrand when whirled round with a ſtring. The fluid, indeed, advances in the crooked direction that we ſee it, occaſioned by the reſiſtance of the air; but I rather conceive, that in theſe *exploſions* the particles of the fluid being accumulated and greatly compreſſed at the place where they iſſue from the conductor, they ruſh off in a *conical* form, and in the inſtant that they are detached from the conductor, they form themſelves into a *ſphere*, which, by the natural repulſion of its component particles, expands and enlarges till it is enveloped in the maſs of matter that attracted it.—But this, indeed, is merely a conjecture, and may be contrary to fact.

An Electrical PLANETARIUM.

BY the attractive and repulſive powers of electricity a great variety of amuſing mechanic appendages might be added to an electrical machine, whoſe motions might be varied and regulated almoſt at pleaſure. Among others, a kind of *electrical orrery* or *planetarium* has been invented, conſiſting of ſmall glaſs ſpheres, blown extremely thin: Theſe are placed on a metal plate, and environed with circles of thick braſs wire, inſulated with ſealing-wax or glaſs; of ſuch a heighth from the plate that the centre of the glaſs ſpheres may be parallel to the wire circles. One of theſe circles may repreſent the orbit of *Saturn*, another of *Jupiter*, &c.—and a braſs ball may be placed in the centre for the *Sun*. Theſe circles being connected with the conductor of the machine by a wire, and a glaſs ſphere placed between each, the ſpheres will perform their revolutions round their orbits, and, at the ſame time, acquire a rotation on their axes, or the point which touches the metal plate.—Theſe movements of the glaſs ſpheres may convey ſome idea of the annual and diurnal motion of the earth and other planets, but a very imperfect one of the *cauſe* of that motion.

The revolutions of the glaſs balls are no other than the neceſſary conſequences of electrical attraction and repulſion, as before explained: On the ſame principles they might be made to move in a ſtrait line a-croſs the chamber, or in any other direction. When the machine is ſet in motion the balls will be firſt attracted to the braſs circles, by which means the point that touches the circle will become electrified, and then be immediately repelled; the electric matter being but partly diffuſed over the ſurface of the glaſs, other parts of the ſurface will be ſucceſſively attracted and repelled by the braſs ring, while the electric matter is diſcharged on the metal plate: This muſt conſequently give the glaſs ball a kind of ſpinning motion on the point which touches the plate, at the ſame time that it muſt have a progreſſive motion round the circle.

This experiment will ſucceed beſt if the metal plate be likewiſe inſulated on the circular board beforementioned, and connected by a chain to the negative conductor: Or, the plate may be electrified by the *prime* conductor, while the circles are in contact with the other.

The Effects of FLAME *in Electricity.*

FLAME appears to be a very good conductor of the electric fluid. As it may be ſuppoſed to conſiſt of an almoſt infinite number of minute particles of that matter which it conſumes, it has as powerful (and perhaps greater) tendency to receive and throw off the electric fluid from a body electrified, as the moſt acute *points*.———If a lamp, made of metal, be placed on an inſulated ſtand (to which a prime conductor may be connected) and the flame of it placed a few inches diſtant from the electrical glaſs cylinder, the flame will be found to collect and conduct the electricity full as well as the pointed wire collectors; and ſtrong ſparks may be taken from the prime conductor.—A candle will not do ſo well in this experiment, the tallow and cotton being bad conductors, unleſs one end of a wire be made to touch the flame, and the other end connected to the prime conductor.—If a ſmall coated phial be held by the hook, and the outward coating be brought within an inch or two of the flame of the lamp, or of a candle, it will be ſtrongly charged in a ſhort time.[c]

TAKE a coated phial, containing about a pint, with a ſmall braſs ball at the end of the wire, and charge it *poſitively* at the inſide; then apply one end of the diſcharging-rod to the outſide coating, and hold the flame of a candle between the other end of the rod and the wire of the phial, about an inch diſtant from each; the flame will by this means be ſtrongly blown from the ball of the phial towards that of the diſcharging-rod; but if the phial be *negatively* charged, the flame will have a contrary direction—from the diſcharging-rod to the phial.

IF the phial be highly charged it will explode at more than two inches diſtance through the flame of the candle; the electric light appearing generally of a curious blue colour. But this experiment has a much finer effect when performed in the following manner; —Let the large inſulated board (ſo often before mentioned) be once more introduced, and placed on the table; then charge one phial *poſitively*, very highly, ſo that the electric fire may ſtream out at the ſmall ball at the end of the wire; let another phial of the ſame ſize be charged equally ſtrong with the *negative* electricity; place both the phials thus charged on the board, ſo that the knobs may be four or five inches from each other—if the flame of a candle be then brought between the two knobs, the phials will both explode with a loud report, and a ſtrong ſpark fly from one ball to the other with a very curious appearance. I have frequently made the phials explode in this manner at more than ſix inches diſtance; in which caſe the ſpark will have the ſame curved or crooked direction as when drawn from the end of a large conductor.

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[c] I ſhould think it would be a deſireable diſcovery, if an accurate method could be thought of for determining the difference (if any) between flame ariſing from *oleaginous* and other ſubſtances, with reſpect to its conducting power.

THE following is a very beautiful experiment, when it is made to ſucceed properly,—take the two phials, charged as before, (but phials of a larger ſize are better for the purpoſe) and place them as far from each other as the board will admit of; let a range of candles be then inſerted in a frame or piece of wood, about two inches diſtant from each other, the flames of each exactly parallel; when theſe candles are quickly introduced between the knobs of the phials, the ſpark will be ſeen to dart through all of them, and have the appearance of a line of fire variegated in a thouſand different curves.

The Effects of ELECTRIFIED WATER.

IT is extremely entertaining to behold a matter which has the appearance of fire proceed immediately from a body of water. A ſtream of *fiery water* ſeems rather an hyperbole than a real fact; But ſuch appearances are eaſily produced.———Let a pewter baſon be placed on the inſulated board, and connected to either conductor; a ſmall ſtream of water being then poured into the baſon from another veſſel, will, when the room is darkened, aſſume a very lucid and curious appearance; the ſtream, before it reaches the baſon, will be divided into a great number of very ſmall drops, and each being illuminated, will appear like a fiery rain.

If a capillary glaſs ſyphon be ſuſpended from the conductor in a ſmall bucket of water, though the water falls from it only in ſmall drops, yet upon turning the machine it will iſſue out in a full ſtream, with a luminous appearance. But a method or rendering this experiment much more beautiful is the following —Take two of the fore-mentioned ſyphons and buckets of water, and ſuſpend one of them from the poſitive, the other from the negative conductor, at ſuch a diſtance from each other that the ends of the ſyphons may be about three or four inches apart; when the machine is ſet in motion the two ſtreams will attract each other, and ſometimes, beautifully uniting, form themſelves into one;—the illumination of the ſtreams will alſo afford a very pleaſing ſight in a dark room.

If the buckets are ſuſpended on two *poſitive*, or on two *negative* conductors, the ſtreams of water will repel and recede from each other as much as they were before attracted.

If a pretty large glaſs veſſel, about three parts full of water, be held under the prime conductor, with a chain or wire hanging from the conductor ſo that the end of the chain may touch the ſurface of the water, (taking care to keep the upper part, and all the outſide of the glaſs veſſel quite dry) the water will become electrified, and continue ſo for ſome time after it be taken from the conductor, and a ſpark may be drawn from its ſurface. Were a perſon to graſp the glaſs veſſel with one hand, while the water is electrifying, and at the ſame time bring his other hand to the conductor, he would experience the ſame kind of ſenſation that ſo greatly terrified Profeſſor Muschenbroeck, and produced the diſcovery of the *Leyden phial.*

Electricians are now not quite ſo apprehenſive of *danger* in repeating this experiment as the Profeſſor was;—They have ſometimes given it an agreeable variation by ſubſtituting a beaker of *wine* or *punch* in the place of ſimple water; and having *charged* the *electrical bumper*, in the manner before mentioned, they have drank it off in ſocial good humour to the memory of that lucky event.

Dr. Franklin, ſome years ago, with other gentlemen, concluded a campaign of electrical operations in a very agreeable and humorous manner, in a party of pleaſure on the banks of the *Skuylkil*, in *Philadelphia.* They fired ſpirits by an electrical ſpark conveyed thro' the river. A turkey was then killed for their dinner by the electrical ſhock, and roaſted by an electrical jack, before a fire kindled by the electrical bottle; when the healths of all the famous electricians in *England*, *Holland*, *France*, and *Germany*, were drank in *electrified bumpers*, under a diſcharge of guns from the electrical battery.[d]

I cannot help thinking but that a few of theſe *electrified bumpers* at a "Feaſt of Reaſon," would generally prove to be an excellent *ſpecific* againſt the various diſorders ariſing from *ſpleen*, *vapours*, *and ill-humour*—provided they are not of too long ſtanding.

A great force of electricity may be conveyed thro' a body of water.—Set a pewter baſon on the inſulated board, in contact with the prime conductor, and let a coated phial be likewiſe connected with it, ſo as to become charged; the phial may either be placed on the ground, or on the table, with a chain from the outward coating hanging down on the floor. If we would chuſe to conduct this experiment in a manner ſomewhat *myſterious*, a quantity of thin ſheet lead,

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[d] Franklin's Letters, p. 37.

ſpread over the floor of the room, may be concealed under a carpet. When the phial is charged, let a perſon take a tea-kettle (or any other metal veſſel) of water in his hand, and pour a ſtream into the baſon; and he will immediately receive a forcible vibration through the whole body, from his hand to his feet. This may not improperly be called the *aquatic ſhock*, which would be apt to ſurpriſe an electrician himſelf, if he was not aware of his ſtanding on lead.

THUS we may cauſe a train of gunpowder to be fired, a cannon to be diſcharged, or a candle lighted by pouring a ſtream of cold water from one veſſel to another. But as a perſon is not always diſpoſed to receive theſe *aquatic ſhocks* through his body, he may have a veſſel made with a glaſs handle to it, and complete the circuit by the addition of a chain; but the moſt convenient thing for the purpoſe is a copper tea-urn, which by turning the cock would produce a proper ſtream.

WHEN a long narrow trough of water is made a part of the circuit in the diſcharge of a large jar or battery, if a perſon's hand be immerſed in the water at the time of the exploſion, he will feel an odd kind of vibration in the water, occaſioned by the paſſage of the electric fluid through it, but a very different ſenſation from that of the ſhock.

THE electric ſhock may be conveyed through a very large body of water, by making it a part of the circuit. —It has been done more than once through the river *Thames*, by Dr. WATSON and others.

Of the ELECTRICAL BATTERY.

A Great number of coated phials connected together, ſo that all their force may be combined in one exploſion, is called an *electrical battery*. Theſe phials are generally ranged in a wooden frame or box, covered at the bottom with ſheet lead or tinfoil; from this projects a thick wire hook, which ſerves as a communication to the outſide of all the phials; and the inſides are all connected by ſmall rods of metal laid over the mouths of the phials.

WITH ſuch a force as this (ſuppoſing the battery to contain thirty or forty ſquare feet of coated glaſs) a great number of ſurpriſing and intereſting experiments may be performed; and though it be a very formidable appendage to the electrical machine, and ought always to be uſed with caution, yet we cannot ſay that the apparatus of an electrician is complete without it, as many experiments which are neceſſary to be made, in order to aſcertain the nature and power of electricity under various circumſtances, can be performed by no other means; and I am perſwaded that the ſatisfaction every electrician muſt receive from the uſe of this appendage, will ſufficiently repay him for the labour and expence he may beſtow in conſtructing it, which, indeed, need not be very conſiderable.

" THE diſcharge of a large electrical battery (ſays " Dr. PRIESTLEY) is rather an awful than a pleaſing " experiment, and the effects of it, in rending various " bodies, in firing gunpowder, in melting wires, and " in imitating all the effects of lightning, never fail " to be viewed with aſtoniſhment."

FINIS.

ELECTRICAL APPARATUS

Sold by J. B. BECKET, oppoſite the *Exchange*
In CORN-STREET, BRISTOL.

MACHINES, of various Conſtructions and Workmanſhip, ſimple or compound, from Two Guineas to — —	10	10	0
A MACHINE on a new and improved Conſtruction, adapted to every Purpoſe of Electricity, both Medical, Philoſophical, and Entertaining; with a large Cylinder, and inſulated Rubber, a Coated Phial, Conductor and Stands	5	5	0
COATED JARS, COLLECTORS, CONDUCTORS, and Inſulated DISCHARGING RODS, of all Sizes.			
A THUNDER-HOUSE, demonſtrating a method of preſerving Buildings, &c- from the effects of Lightning,	0	2	6
A TORRICELLIAN, or Double Barometer, for exhibiting an appearance of the *Aurora Borealis;* with Glaſs Cups, and a Mahogany Frame, (excluſive of Quickſilver)	0	13	6
An Exhauſted Glaſs TUBE, for the ſame purpoſe -	0	5	0
Luminous Glaſs BALLS, in which the Electric Light is rendered viſible *in vacuo*, without the uſe of a Machine	0	5	0
Spherical Tubes, which ſhew the above appearance to ſtill greater advantage, — — —	0	7	6
An Apparatus for ſhewing the Nature, Cauſe, and Effects of Lightning and Thunder; and that theſe Phænomena are produced by an accumulation and diſcharge of the Electric Matter. — Several other Appearances of Nature are, by this Apparatus, agreeably imitated & explained, *viz.* a Tornado, or Waterſpout, from the Sea, and a Whirlwind on Land; alſo, a method of conveying the Electric Exploſion, without the uſual Medium of Glaſs, by charging a *Plate of Air*, whereby the nature of Electrical Attraction and Repulſion is exhibited to greater advantage than by any other way - - -	1	1	0
A ſmaller of the ſame kind, by which moſt of the above Experiments may be performed - -	0	10	6
A Pair of Metal Plates, on a Mahogany Stand, for ſeveral entertaining Experiments of Electrical Attraction, &c.	0	5	0
An Electrical ORRERY, repreſenting the motions of the Six Primary Planets round the Sun, and of the Moon round the Earth - - - -	1	1	0
Another kind of Electric Planetarium, conſiſting of ſmall Glaſs Spheres, whoſe Revolutions are performed by Electrical Attraction and Repulſion, — from 5s. to -	2	2	0

—The Glaſs Spheres may be had ſeparate, 3s. per Doz.

A Self

A Self-moving Electrical Wheel, the Revolution of which is effected by the Attraction and Repulſion of the Two oppoſite States of the Electric Fluid - -	1	1	0
A Set of Electrical Bells, 7s. 6d. or - -	0	15	0
An Apparatus for ſhewing that the Electric Attraction, & that of Magnetiſm, are independent, and without effect upon each other - - - - - -	0	2	6
A Plated Glaſs Plane for explaining the nature of charging a Coated Phial; whereby the Electric Fire may be ſeen to accumulate on one ſide, and fly off from the other — making a beautiful appearance in the dark - -	0	1	6
Two ſmall Coated phials, with proper appendages, for ſhewing the nature of Poſitive and Negative Electricity	0	4	0
Glaſs Capillary Siphons, with Cups, for making a very curious Experiment with Water - - - -	0	2	0
An Electrical Print, properly framed, for conveying a ſurpriſing Shock,— uſually called a *Magic Picture*, 3s. 6d. or	0	7	6
Large Cylinders of Sealing-Wax, for procuring a *Negative* Electricity — various Prices			
Electrical Batteries, made of any ſize, or required force, and properly erected for making Exploſions.			
A large Coated Jar, with an improved Electrometer	1	1	6
An Electrometer on an inſulated Stand, whereby the charged Phial may be made to explode in equal Diſcharges of any required degree of force - - - - -	0	5	0
Electrometers for determining the force and quantity of the Charge *before* the Exploſion			
A Stool, with Glaſs Supporters, for electrifying a perſon ſitting on it - - - - - - -	0	10	0
Ditto plated with Tinfoil, for Experiments - -	0	12	0
An Inſtrument for curing the Tooth-ach - -	0	1	0
A Glaſs Inſtrument for electrifying the Eye -	0	2	5
Braſs Chain, and Metal Plates, for conveying the Electric Fluid to any part of the Body.			
Wire, of all ſizes, Amalgama, &c.			

*** *The above, and various other Apparatus, are generally kept ready made; — Gentlemen who chuſe their Machines, or Appendages made on any other different Conſtruction, may have their orders executed on the shortest Notice.*